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TWENTY-THIRD

PROGRESS REPORT

OF

THE FIRESTONE TIRE & RUBBER CO.

ON

105 MM BATTALION ANTI-TANK PROJECT

Contract No.
DA-33-019-ORD-33 (Negotiated)
RAD ORDTS 1-12383

THE FIRESTONE TIRE & RUBBER CO.
Defense Research Division
Akron, Ohio

JUNE, 1952

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INDEX

ABSTRACT

There are four Firestone 105mm BAT weapon systems in use. The location and use of each is given. A schedule of manufacture for four additional weapon systems is presented and the changes incorporated in these additional weapons are explained. New developments in the weapon design are discussed.

The direct sights which have been subjected to extended firing programs have developed some difficulties and are being returned to Frankford Arsenal for reworking. The design for indirect sight mounting is shown.

The accuracy of the T46 spotting rifle has been measured using the spotting cartridges T175 and T176. The data for the firings are presented and the results discussed.

The various modifications to the nose element mounting and tee cap, studied in investigating the causes for the malfunctions of the T138E57 HEAT projectiles, have been listed. The test data are presented and the tests discussed.

Two accuracy firings were made at a 2000-yard range with the T138E57 projectile. The firing data are given.

There were no tests conducted with the T171 projectile during the month.

The firing tests using a new housing design for the T119 projectile are reported and the results analyzed. A revised housing is illustrated.

Various programs in the field of penetration are presented. Data are given for studies of penetration using T171 bodies, the effect of the booster system, machined versus drawn liners and the effect of rotation.

A calculation and measurement of impulse by the T138E57 projectile when passing through a wood bursting screen is presented and a firing program to check results is reported. Other investigations involving the role, in the malfunctions, of the various fuze system elements are discussed. Performance tests of the Fuze, PD, T222E4 were made and the data are given.

THE WEAPON SYSTEM

Four Firestone BAT weapon systems, each consisting of, T137E1 rifle, T152E2 mount, T46 spotting rifle, M62E4 direct sight and T183 sight mount, are mounted on M38 1/4-ton trucks and in use at the following locations:

Unit 1. Fort Benning, Georgia, for informal evaluation tests of weapon and ammunition.

Units 2 and 4. Erie Ordnance Depot for Firestone weapon and ammunition studies.

Unit 3. Aberdeen Proving Ground for ammunition evaluation.

Four additional BAT weapon systems are being manufactured. These systems will consist of T137E2 rifles, T152E4 mounts, T46 spotting rifles, T183 direct sight mounts, M62E4 direct sights and modified M3A1 indirect sights. Scheduled completion of these four systems is as follows:

Unit 5. July 15, 1952
Unit 6. July 30, 1952
Units 7 and 8. Sept. 15, 1952

The T137E2 rifle (Units 5, 6, 7 and 8) differs from the T137E1 in that it incorporates the M27 breech mechanism and a barrel 105 in. long. The T152E4 mount incorporates the following modifications: (1) firing buttons are located in the handwheel knobs instead of in the wheel center (See Fig. 1), (2) positive leg locks, (3) lock for keeping mount in free traverse and (4) mount for the modified M3A1 indirect sight. (See Fig. 2).

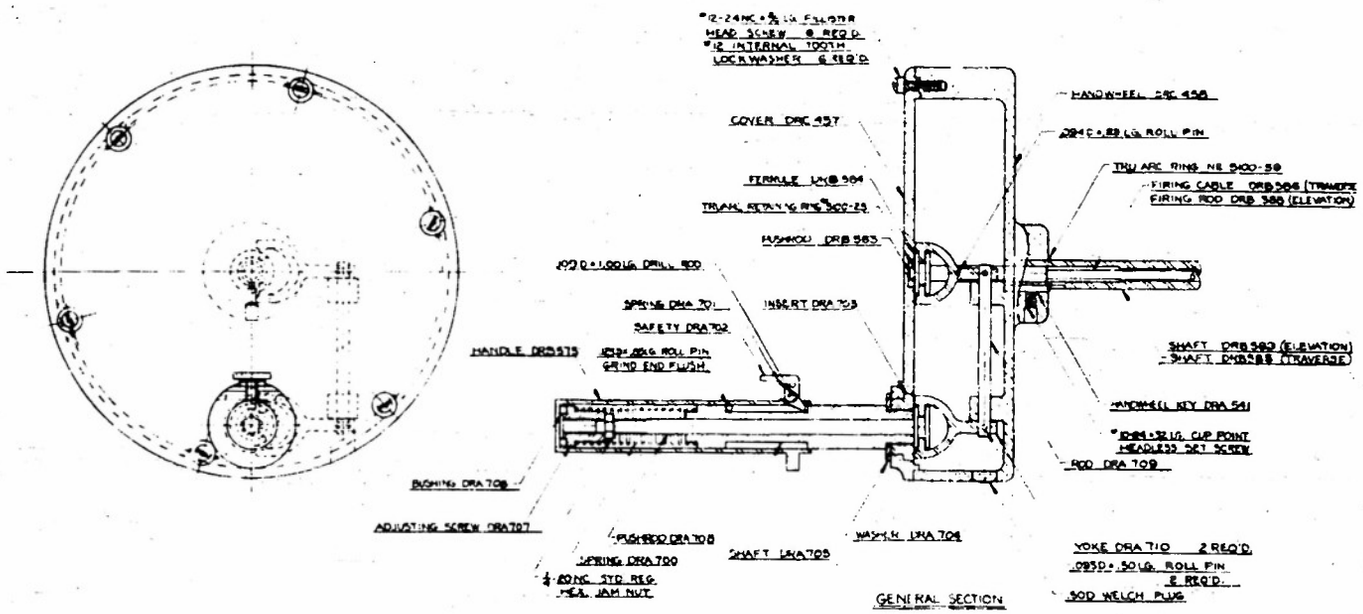

Fig. 1. Redesigned Firing Control.

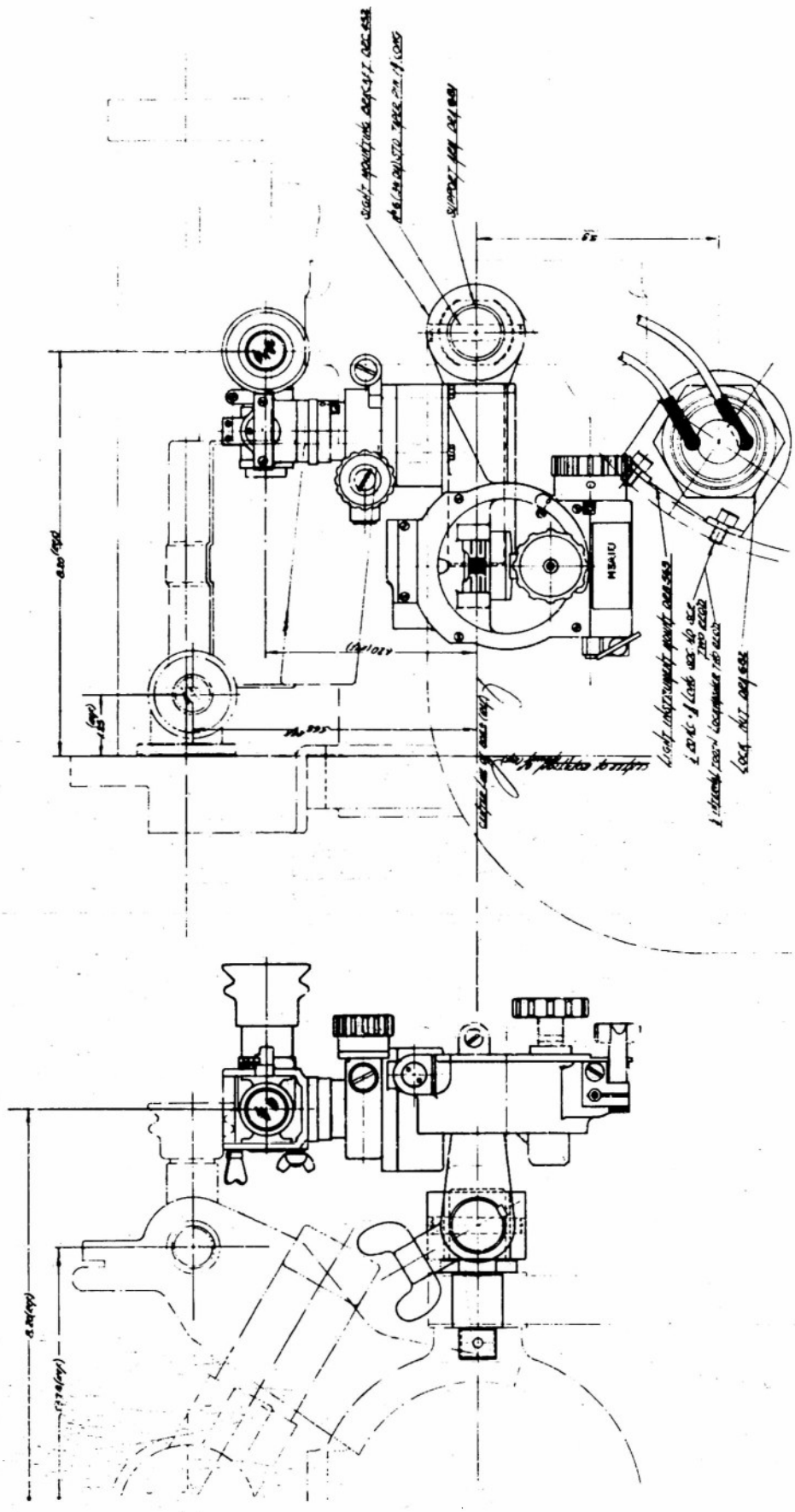

Fig. 2. Mount for Modified M3A1 Indirect Sight.

New Developments

A rubber shock pad is being designed and will be manufactured for the direct sight. When completed, vibration tests are to be made.

A recoil mount for the spotting rifle has been discussed with Springfield Armory and it is concluded that such a mount would seriously affect the operation of this type of rifle; therefore, no further work is contemplated on such a mount.

A major caliber mount to be made of aluminum is in the preliminary design stage. It is believed that sufficient rigidity can be obtained in a mount weighing only 90 pounds.

Sighting System

Although it is intended that the T137 weapon system will include both a direct and an indirect sight, the weapon assemblies produced to date have not included an indirect sight.

Direct Sight

Frankford Arsenal has reported (Report No. R-1068) that the telescope mounts, T183, which have been subjected to extended firing programs have developed a boresight backlash of the order of 0.5 mil and have attributed the difficulty to the brinelling of the protective surface finishes used on internal parts. Consequently all T183 direct sight mounts have been recalled for removal of the protective finish, general reconditioning, and installation of a new molded-type head rest.

One direct sight, mount No. 12, telescope M62E4 No. 18009, was shipped to Frankford June 28, 1952. The remaining three sights will be returned for processing as rapidly as circumstances permit.

Indirect Sight

The following indirect sights have been received from Frankford Arsenal:

Mount M3A1 E1	Telescope M62	Adapter M9
#2	#286	#HO1641
#7389	3490	#4612
#2438	7883	#1379
#7449	4735	No Serial No.
#7446	8392	#HO2199

Indirect sight brackets are being manufactured. A sketch of the proposed mounting bracket is shown in Fig. 2.

Spotting Rifle

(Tests at Erie Ordnance Depot)

The accuracy of the spotting rifle T46 No. 1 has been measured using the spotting cartridges T175 and T176. The T175 was designed by Frankford Arsenal and has an air gap fuze; the T176 was designed by Winchester Repeating Arms Company and is of the 'differential crimp' type. The spotting rifle was mounted on a T152E2 mount. The target, a homogeneous armor plate 107 in. wide by 137 1/2 in. high by 3/4 in. thick, was located at a range of 1030 yards. The optical axis of the sight (M62E4-T183) and the rifle boresight were adjusted to intersect at the center of the target. Tracer cartridges, T177, were employed to assist in ranging in on the target.

No difficulty was experienced in maintaining rifle and sight alignment or in chambering any of the cartridges, but 22 of the 53 cartridges fired failed to eject properly from the chamber. The difficulty was found to be caused by a bent extractor spring.

T175 Spotting Cartridge

(Tests at Erie Ordnance Depot)

Fifteen rounds were fired for accuracy and nine for determination of velocity. The accuracy rounds all struck the target

and functioned by giving a plainly visible flash of light and puff of smoke. The V.P.E. was ± .27 mil; the H.P.E. was ±.17 mil.

The nine velocity rounds functioned on the shorting screen (two layers of lead foil separated by heavy kraft paper), thereby demonstrating the sensitivity of the bullet, but casting some uncertainty upon the reliability of the measurements which showed the average instrumental velocity to be 1828 ft/sec at a distance of 79.3 ft. from the muzzle.

The firing record is shown in Table I.

T176 Spotting Cartridge

(Tests at Erie Ordnance Depot)

Fourteen T176 cartridges were fired for accuracy and five for velocity determination. All of the fourteen accuracy rounds struck the target, with visible light and smoke, and showed a V.P.E. of ±.26 mil and a H.P.E. of ±.46 mil.

The average instrumental velocity of the five velocity rounds was 1868 ft/sec at a distance of 80.4 ft. from the muzzle. This average velocity is in general agreement with previous tests with ammunition from the same lot, using the same rifle.

The firing record is shown in Table II.

Future Program

1. Evaluate the design changes in T137E2 rifle and T152E4 mount.

2. Continue trajectory-matching studies of spotting and major caliber ammunition.

3. Stress analysis studies of the T152 E2 mount, using strain gages, have been initiated and will be continued.

4. Complete design study of an aluminum mount.

5. Start design layouts for semi-automatic rifles.

6. Continue study of rifle design using annular ring of propellent.

Table I
Accuracy Firing Data
T46 Spotting Rifle, T175 Spotting Cartridge
Homogeneous Armor Target at 1030-yard Range

Date June 23, 1952 Program Supplementary VII System Shoot

PROJECTILE
Model T175 & T177
Type Spotting & Tracer Rounds.
Weight (Nominal) _____
C.G. Location _____
Bourrelet Dia. (Nom.) _____
Special Features _____

TEMPERATURES
Ammunition Storage - 75°
Ambient - 85°

SCREEN DISTANCES
51'10" | 38'0"

TEST GUN
Model T46 No. 1
Type .50 cal. spotting
Length of Tube 92 in.
Twist of Rifling 1-12
Sighting Equipment M82E4 Elbow Telescope
Bore Dia. (Lands) _____

T137E1 No. 7 Unit
Chamber 2181336
Ring 2282498-3
Tube 2181280

MISCELLANEOUS DATA
Range 1030-yard Shoot target.
Propellant IMR 4831, AL 29388
Type _____ web _____ Charge Wt. Varies
Proof Director E. Huffman
Observers M. Tassin, C. Engebretson.

Corrected to center of target from 1000 yd. ballistic reticle setting at top of target. Top of target to center = 1.88 mils

Corrected to 24.46 mils V_2 + 1.43 mils H

Round No.	Type of Cartridge	Type of Bullet	Powder Charge (grains)	Wind Vel. & Dir.	Chamber Pressure	Muzzle Velocity Instr.	Muzzle Velocity Actual	Elev. (mils)	Azimuth (mils)	Position of Hit (inches) Vert.	Position of Hit (inches) Horiz.	Corrected Position of Hit — mils Vert.	Corrected Position of Hit — mils Horiz.	Bourrelet Diameter Front	Bourrelet Diameter Rear	Clearance Front	Clearance Rear	Observations
2406-1	T-177	Tracer	125			1836	—											
2407-2	T-177	Tracer	125			1836	—											
2408-3	T-177	Tracer	125			—	—											
2409-4	T-177	Tracer	125			—	—											
2410-5	T-177	Tracer	125			—	—											
2411-6	T-177	Tracer	125			—	—											
2412-7	T-175	Spotting	126			1880	—	Spotted behind first screen										
2413-8	T-175	Spotting	126			1879	—	Spotted behind first screen										
2414-9	T-175	Spotting	126			1864	—	Spotted behind first screen										
2415-10	T-177	Tracer	125					24.46	+1.48	—	—							Tracer used to check elevation and azimuth
2416-11	T-175	Spotting	126			—	—	24.46	zero	—	—							Incomplete extraction of shell case
2417-12	T-175	Spotting	126					24.46	+1.48	+28.56	+30.50	+.44	+.82	"	"	"	"	" "
2418-13	T-175	Spotting	126					24.46	+1.43	+18.81	+26.50	+.61	+.72	"	"	"	"	" "
2419-14	T-175	Spotting	126					24.46	+1.43	+41.31	+28.00	+1.12	+.76	"	"	"	"	" "
2420-15	T-175	Spotting	126					24.46	+1.43	-27.44	+6.50	-.74	+.18	"	"	"	"	- -
2421-16	T-175	Spotting	126			1882	—	24.46	+1.43	—	—							Velocity Round
2422-17	T-175	Spotting	126			—	—	24.46	+1.43	—	—							Velocity round - Incomplete extraction of shell case
2423-18	T-175	Spotting	126					24.46	+1.43	+4.44	+34.00	+.12	+.92					
2424-19	T-175	Spotting	126					24.46	+1.43	+7.44	+24.50	+.20	+.66	Incomplete extraction of shell case.				
2425-20	T-175	Spotting	126					24.46	+1.43	+2.94	+22.00	+.08	+.59	Failed to extract shell case from chamber				
2426-21	T-175	Spotting	126					24.46	+1.43	+19.31	+43.00	+.62	+1.16	"	"	"	"	" "
2427-22	T-175	Spotting	126					24.46	+1.43	+25.81	+31.00	+.70	+.84	"	"	"	"	- "
2428-23	T-175	Spotting	126					24.46	+1.43	+20.94	+33.00	+.57	+.89	"	"	"	"	" "
2429-24	T-175	Spotting	126					24.46	+1.43	+5.19	+38.00	+.14	+1.03	"	"	"	"	- "

Center of Impact _____
Probable Error - Vertical _____
Probable Error - Horizontal _____

Continued on next page.

Signed - W. Harvey

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Table I (Cont.)
Accuracy Firing Data
T46 Spotting Rifle, T175 Spotting Cartridge

Date June 23, 1952 Program Supplementary VII System Shoot

PROJECTILE
Model T175 & T177
Type Spotting & Tracing
Weight (Nominal) _____
C.G. Location _____
Bourrelet Dia. (Nom.) _____
Special Features _____

TEMPERATURES
Ammunition Storage - 75°
Ambient - 83°

TEST GUN
Model T46 No. 1
Type .50 caliber Spotting Rifle.
Length of Tube 32 in.
Twist of Rifling 1-12
Sighting Equipment M62E4 Elbow Telescope
Bore Dia. (Lande) _____

MISCELLANEOUS DATA
Range 1030 yd. steel target
Propellant IMR 4831, AL 29383
Type _____ Web _____ Charge Wt. Varies
Proof Director E. HUFFMAN
Observers M. TOOHIG, C. ENGEBRETSON

SCREEN DISTANCES 81'10" | 55'0"

Corrected to center of target from 1000 yd. ballistic reticle setting of top of target. Top of target to center = 1.88 mils

Corrected to 24.46 mils V; +1.43 mils H

Round No.	Type of Cartridge	Type of Bullet	Powder Charge (Grains)	Wind Vel. & Dir.	Chamber Pressure	Muzzle Velocity Instr.	Muzzle Velocity Actual	Elev. (mils)	Azimuth (mils)	Position of Hit (inches) Vert.	Position of Hit (inches) Horiz.	Corrected Position of Hit - mils Vert.	Corrected Position of Hit - mils Horiz.	Bourrelet Diameter Front	Bourrelet Diameter Rear	Clearance Front	Clearance Rear	Observations
2430-25	T-175	Spotting	126					24.46	+1.43	+13.81	+40.50	+.87	+1.09	Failed to extract shell case from chamber.				
2431-26	T-175	Spotting	126					24.46	+1.43	+2.44	+27.00	+.07	+.73	"	"	"	"	"
2432-27	T-175	"	126					24.46	+1.43	+16.56	+21.00	+.45	+.57	"	"	"	"	"
2433-28	T-175	"	126					24.46	+1.43	+13.81	+17.50	+.87	+.47	"	"	"	"	"
2434-29	T-175	"	126			—	—							Failed to extract shell case from chamber				
2435-30	T-175	"	126			1766	—					Fired for velocity		"	"	"	"	"
2436-31	T-175	"	126			1811	—							"	"	"	"	"

Components of T175 Spotting Cartridge
Case - FAT 5 Dwg FC 2888
Bullet - T140E14-35 Observing
Primer - WRA No. 267
Muzzle Velocity - 1901 f/s. (T46 No. 12)
Pressure - 39,000 psi.
Lot - FAX-50-1736
Dated - May 1952
Remarks - Cartridges loaded to a velocity to match Firestone 105mm BAT T138E57 round.

Components of T177 Tracer Cartridge
Case - FAT 5 Dwg FC 2888
Bullet - T139E3 Tracer
Primer - WRA No. 267
Muzzle Velocity - 1827 f/s
Pressure - 40,600 psi. (piezo)
Lot - FAX-50-1675
Dated - Feb 1952
Remarks - Cartridges loaded to a velocity to match Frankford Arsenal 105mm BAT T118E13 round.

NOTES:
1. Sight and base axes paralleled upon a coincident point on the 1030 yard target.
2. All rounds rotated end over end and thrice (3) times and hand loaded into chamber. Breech bolt was not allowed to slam home but was eased closed. Only enough force to properly seat bolt and cartridge was exerted.
3. Rear mounting screws of spotting rifle became loose during firing and permitted play in the vertical plane
4. Cause for faulty ejection was due to a bent extractor spring
5. Wind varied from 6-12 mph. and from 16°-70°

Center of impact V = +.34 ; H = +.67 mil
Probable Error - Vertical .27 mil.
Probable Error - Horizontal .17 mil.

Signed - W. H. Harvey

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Table II
Accuracy Firing Data
T46 Spotting Rifle, T176 Spotting Cartridge
Homogeneous Armor Target at 1030-yard Range

Date June 18, 1952 Program Supplementary VII Accuracy Program Against Armor Plate.

PROJECTILE
Model T176 Cartridge
Type Spotting
Weight (Nominal) _____
C.G. Location _____
Bourrelet Dia. (Nom.) _____
Special Features Nominal Muzzle Velocity 1800 ft/sec
T177 tracer cartridges, MV = 1887 f/s (nominal) were used as range finders. Lot PA-X50-1675 (See Table I for details)

Ambient Temp. = 76°F

TEST GUN
Model T46 No. 1
Type .50 Cal. Rifle
Length of Tube 32 in.
Twist of Rifling 1-12
Sighting Equipment T183 sight mount No. 12
Bore Dia. (Lands) ---

Screen Distances: 53' ½" — 54.83'

MISCELLANEOUS DATA
Range 1030 yds.
Propellant
Type _____ web _____ Charge Wt. _____
Proof Director M.E. Tarhig
Observers E. Lowry, E. Clark

Velocities measured with shorting screens. Velocities are at 80.4 ft. from the muzzle. All rounds functioned on impact

Round No.	Type of Cartridge	Type of Bullet	Purpose	Wind Vel. & Dir.	Chamber Pressure	Muzzle Vel. (Instr.) (ft/sec)	Elevation* yards	Elevation* mils	Azimuth (mils)	Position of Hit (inches) Vert.	Position of Hit (inches) Horiz.	Corrected to 24.07 mils V; 0 mils H: Corrected Position of Hit – mils Vert.	Corrected to 24.07 mils V; 0 mils H: Corrected Position of Hit – mils Horiz.	Bourrelet Diameter Front	Bourrelet Diameter Rear	Clearance Front	Clearance Rear	Gun Functioning
2437 - 1	T176	Spotting	Velocity	5 - 4°		1858												
2438 - 2	T176	"	"	5 - 8°		1882												
2439 - 3	T176	"	"	6 - 5°		1864												
2440 - 4	T177	Tracer	Ranging				1000	24.07	0									
2441 - 5	T177	"	"				900	21.13	0									Failed to extract
2442 - 6	T177	"	"				1000	23.32	0									
2443 - 7	T176	Spotting	Accuracy				1000	23.32	0	-43	+8	-.41	+.22					
2445 - 8	T176	"	"				1000	24.07	0	-36	+11	-.97	+.30					
2446 - 9	T176	"	"				"	"	0	+48	+26	+1.30	+.70					
2447 - 10	T176	"	"				"	"	0	+26½	+43	+.72	+1.16					
2448 - 11	T176	"	"				"	"	-1.45	+44	+1	+1.19	+1.48					Failed to extract
2449 - 12	T176	"	"				"	"	"	+37	-7	+1.00	+1.26					
2450 - 13	T176	"	"				"	"	"	+34	-7	+.92	+1.26					
2451 - 14	T176	"	"				"	"	"	+28½	-7½	+.77	+1.24					
2452 - 15	T176	"	Velocity			1871												Failed to extract
2453 - 16	T176	"	Accuracy				"	"	"	+32	-20	+.86	+.41					
2455 - 17	T176	"	"				"	"	"	+29½	+3	+.64	+1.55					Failed to extract
2456 - 18	T176	"	"				"	"	"	+19	-4	+.51	+1.34					
2457 - 19	T176	"	"				"	"	"	-22	-12½	-.59	+1.11					
2458 - 20	T176	"	"				"	"	"	+3	-15	+.08	+1.04					
2459 - 21	T176	"	"				"	"	"	+27½	+3	+.74	+1.55					
2460 - 22	T176	"	Velocity			1865	"	"	"									
					Average 1868 f/s													

NONE TAKEN

Target Size = 107 in. wide × 137½ in. high, × ¾ in. thick (armor plate)

* Corrected to vertical center of target from 1000 yd. ballistic reticle setting at a point 1.49 mils above center of target.

Center of Impact V = +.48 mil; H = +.08 mil
Probable Error – Vertical ±.46 mil
Probable Error – Horizontal .26 mil

* Elevation is given in terms of the ballistic reticle and the aiming point is the top of the target except ½
† Elevation in mils from center of target.

Performance Studies Using T138E57 HEAT Projectiles

The Twenty-First and Twenty-Second Progress Reports presented data on the functioning of one hundred and ten T138E57 HEAT projectiles and nineteen T264 WP projectiles. Approximately 50% of these projectiles detonated properly upon impact with the target. The search for the cause or causes for the malfunctions has continued.

The higher proportion of functioning rounds noted when the rounds are fired without tee caps against a 2-inch pine screen (Twenty-Second Progress Report) suggests that a tee cap of lighter construction might increase the percentage of functioning rounds. Thirty-one T138 E57 HEAT projectiles, embodying various modifications of the nose element mounting and tee cap have therefore been tested. The test data are shown in Table III.

In each of the tests, described in the following paragraphs, the T137E1 No. 4 rifle and mount were used for firing live loaded T138E57 HEAT projectiles of Lot No. PA-E 9588. The target consisted of a 2-inch thick pine board screen at zero degrees obliquity and located 400 ft. from the gun. In previous tests the projectiles of this ammunition lot have shown one function out of ten when fired with tee caps, against 60° armor and eight out of ten when fired without tee caps against a normal 2-inch pine screen.

Test 1
Evaluation of Compression Washers (Figure 3)

Six rounds, modified by inserting a flat spring compression washer (compressed height .010 in., free height .030 in. minimum) between the crystal and the tee were fired against a bursting screen. In addition to the compression washer, other modifications were: wrapping two layers of cellulose tape around the outside of the crystal, and replacing the cambric insulator by a felt pad placed between the terminal and the tee cap. Three rounds functioned on the bursting screen and three rounds impact-detonated on the steel back-up plate. This performance is much better than that of projectiles without modification but much poorer than the performance of those fired without tee caps. The firing record is given in Table III.

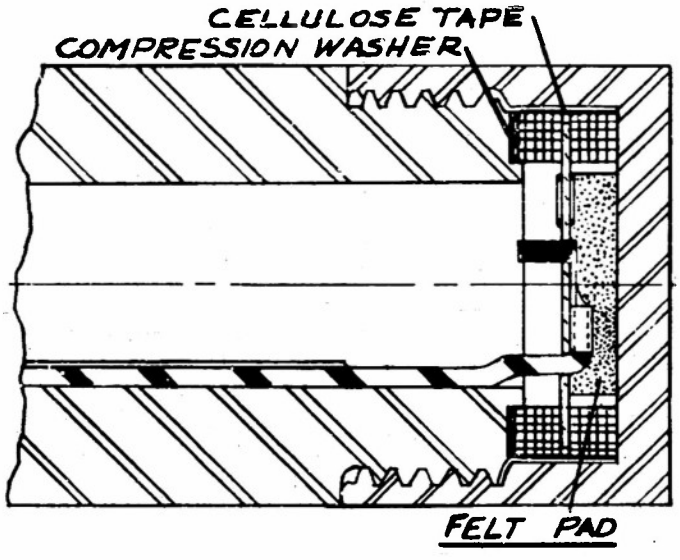

Fig. 3. Tee Cap and Nose Element. With Compression Washer.

Test 2
Thin-Wall Tee Caps With Reduced Clearance (Figure 4)

Ten rounds having tee caps as shown in Fig. 4 were tested. Nine rounds functioned on the screen and one round impact-detonated on the steel plate.

Five rounds having caps as above, but with the felt washer of Fig. 3 substituted for the cambric insulating washer, were

fired. Four of these rounds functioned on the bursting screen, the other round impact-detonated on the steel back-up plate. Table III is the firing record for these rounds.

This record of thirteen functions out of fifteen rounds is at least as good as previously obtained by firing without tee caps and is regarded as satisfactory.

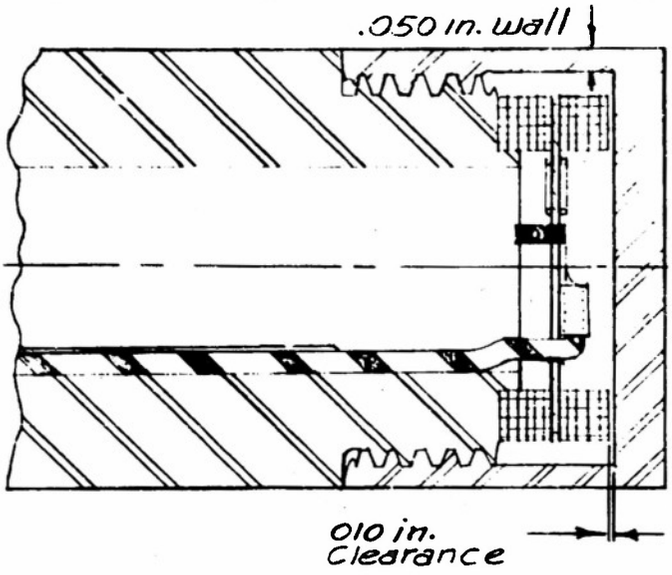

Fig. 4. Tee Cap and Nose Element.
Thin-Wall Cap, Reduced Clearance.

Test 3
Thin-Wall Tee Caps With Normal Clearance (Figure 5)

Five rounds having tee caps as shown in Fig. 5 were fired through the bursting screen. Four of the five rounds functioned on the screen and the fifth round impact-detonated against the steel plate. The firing record is found in Table III.

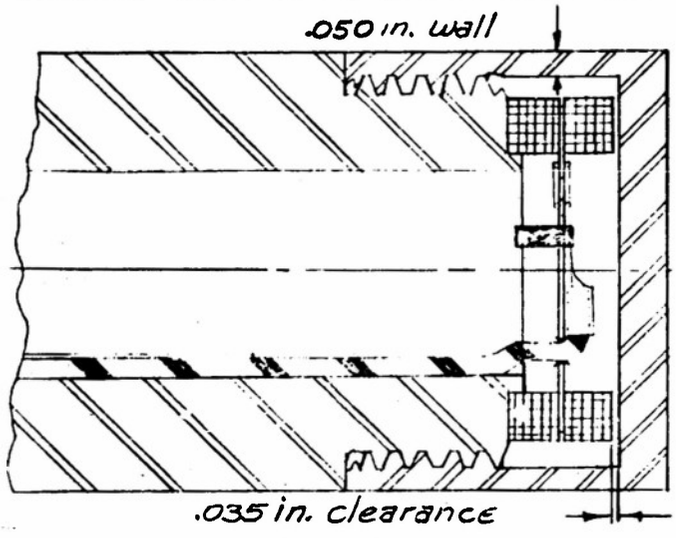

Fig. 5. Tee Cap and Nose Element.
Thin-Wall Cap, Normal Clearance.

This performance record is similar to that of Test 2 and indicates that the thin cap, not the reduced clearance, is responsible for the improved performance.

Test 4
Heavy-Wall Tee Caps With Reduced Clearance (Figure 6)

Five rounds having tee caps with normal wall thickness (.100 in.) and a clearance of .010 in. between crystal and cap (Fig. 6) were fired through a bursting screen. Two rounds functioned on the screen and a third functioned on the steel plate. The two remaining rounds impact-detonated on the steel plate. The firing data is given in Table III.

These results are much better than were obtained in earlier tests with heavy-wall caps and with a greater clearance.

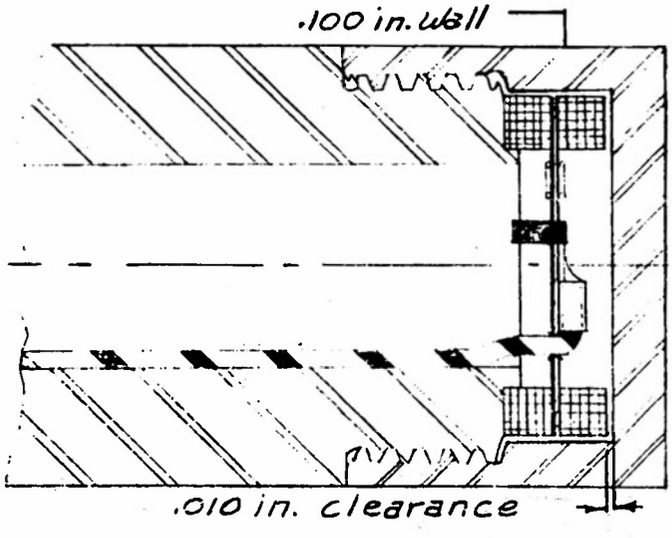

Fig. 6. Tee Cap and Nose Element.
Heavy-Wall Cap, Reduced Clearance.

Table III
Functioning Test Data
Various Modifications of T138E57 Projectile
400-ft. Range, Bursting Screen

Date 6-12-52 Program To determine fuze functioning of T138 E57 HEAT rounds.

PROJECTILE
Model T138 E57 Live
Type Lot FS-E 9588 & Base Element Lot PA-E 8853
Weight (Nominal) 17.4 lb.
C.G. Location 5.25 in. from base.
Bourrelet Dia. (Nom.) 4.582 in.
Special Features See information below for each test.

TEST GUN
Model T139E1 No. 4
Type 105 mm Recoilless Rifle.
Length of Tube 96 in.
Twist of Rifling 1-20
Sighting Equipment M12E4 with T183 Mount
Bore Dia. (Lands) _____

MISCELLANEOUS DATA
Range 400 ft. Wood Burster Screen 6 in Steel witness plate.
Propellent
Type M30 NF web .088 in. Charge Wt. 7 lb. 14 oz.
Lot PA-E 30239
Proof Director Maj. FINNEGAN
Observers C.M. Cox

Round No.	Time of Flight	Proj. Weight (lb.)	Powder Charge (lb. oz.)	Wind Vel. & Dir.	Chamber Pressure	Muzzle Velocity Instr.	Muzzle Velocity Actual	Elev. (mils)	Distance - Top of Crystal to Tee Shldr.	Depth of Cap	Clearance Crystal to Cap (Orig.)	Clearance After Instl. of Washer	Dist. Crystal to Tee Shldr. Using Wshr.	Tee Cap Wall Thickness (Nom.)	Tee Cap Face Thickness (Nom.)	Resistance of Crystal to Ground Ω	Depth of Old Cap	Functioning
TEST 1	Compression Washer Between Crystal & Tee Felt Pad Insulator Between Tee Cap and Crystal Center Plate. Tape Around Crystal. See Fig 3																	
398		17.4	7-14				1664		.637	.672	.085	-.002	.676	.100	.125	135,000		Good
783		"	"				1649		.686	.673	.038	-.003	.676	.100	.125	170,000		Low Order
911		"	"				1663		.644	.673	.029	-.002	.675	.100	.125	135,000		Good
850		"	"				1660		.687	.673	.036	+.001	.672	.100	.125	135,000		Non-Function
868		"	"				1669		.638	.673	.035	+.002	.671 .665 Mod.	.100	.125	140,000		Non-Function
764		"	"				1667		.637	.672	.035	-.008	.676	.100	.125	190,000		Good
TEST 2	Thin Wall Tee Caps. Reduced Clearance. See Fig 4																	
997		17.4	7-14				1659		.639	.649	.010			.049	.124	138,000		Good
772		"	"				1659		.637	.646	.009			.049	.123	140,000		Good
908		"	"				1654		.645	.658	.013			.048	.123	170,000		Good
438		"	"				1655		.649	.660	.010			.048	.124	120,000		Good
918		"	"				1653		.641	.651	.010			.050	.123	160,000		Good
996		"	"				1659		.638	.648	.010			.051	.125	172,000		Good
878		"	"				1664		.640	.650	.010			.050	.124	155,000		Good
437		"	"				1660		.635	.645	.010			.051	.125	145,000		Good
967		"	"				1656		.644	.654	.010			.050	.126	150,000		Low Order
439		"	"				1650		.637	.648	.011			.050	.126	122,000		Good
	Same as Above (Test 2) Except Felt Insulating Pad Added.																	
784		17.4	7-14				1659		.635	.645	.010			.050	.125	192,000	.673	Good
775		"	"				1657		.636	.646	.010			.049	.125	170,000	.672	Good
982		"	"				1660		.644	.654	.010			.051	.125	137,000	.673	Good
798		"	"				1663		.636	.646	.010			.050	.126	153,000	.672	Low Order
888		"	"				—		.634	.644	.010			.048	.125	142,000	.673	Good

Center of Impact _____
Probable Error - Vertical _____
Probable Error - Horizontal _____

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Table III (Cont.)
Functioning Test Data
Various Modifications of T138E57 Projectile

Date 6-12-52 Program To determine fuze functioning of T138E57 HEAT rounds.

PROJECTILE
Model T138E57 Live
Type Lot PA-E 9588 & Base Element Lot PA-E 8858
Weight (Nominal) 17.4 lb.
C.G. Location 5.25 in. from base.
Bourrelet Dia. (Nom.) 4.132 in.
Special Features See information below for each test.

TEST GUN
Model T131E1 No. 4
Type 105mm. Recoilless Rifle.
Length of Tube 95 in.
Twist, R.H. Rifling 1-200
Sighting Equipment M62E4 with T183 Mount
Bore Dia. (Lands) _____

MISCELLANEOUS DATA
Range 400 ft. Wood Bursting Screen 3-in. steel witness plate.
Propellant
Type M10M2 web .083 in. Charge Wt. 7 lb. 14 oz.
Lot PAE 30239
Proof Director Maj. Finnegan
Observers C. M. Cox

Round No.	Time of Flight	Proj. Weight (lbs)	Powder Charge (lb oz)	Wind Vel. & Dir.	Chamber Pressure	Muzzle Velocity Instr.	Muzzle Velocity Actual	Elev. (mils)	Distance-Top of Crystal to Tee Sh'ld'r	Depth of Original Cap	Clearance Crystal to Cap	Depth of Cap	Tee Cap Wall Thickness	Tee Cap Face Thickness	Resistance of Crystal to Ground			Functioning
TEST 3	Thin-Wall Tee Caps With Normal Clearance. See Fig. 5																	
774		17.4	7-14				1664		.646	.673	.037	.683	.049	.098	170,000			Good
440		"	"				1654		.645	.673	.034	.679	.049	.123	155,000			Low Order
349		"	"				1658		.639	.673	.034	.673	.060	.105	135,000			Good
833		"	"				1663		.637	.673	.035	.673	.047	.104	168,000			Good
829		"	"				—		.636	.674	.036	.672	.050	.104	132,000			Good
TEST 4	Heavy Wall Tee Caps With Reduced Clearance																	
788		17.4	7-14				1650		.637	.673	.010	.647	.100 nom.	.125 nom.	160,000			Low Order
972		"	"				1646		.633	.673	.010	.643	"	"	146,000			No function on Wood Complete on steel plate
402		"	"				1644		.634	.673	.010	.644	"	"	168,000			Good on wood. Split Jet
802		"	"				1654		.632	.672	.010	.642	"	"	150,000			No function on Wood Low Order
812		"	"				—		.641	.672	.010	.651	"	"	160,000			Good on Wood.
																Signed - C.M. Cox.		

Center of Impact _____
Probable Error - Vertical _____
Probable Error - Horizontal _____

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Summary

The data for the various modifications of Lot PA-E 9588 that have been tested are shown below in Table IV.

The results of the functioning tests indicate that:

1. A reduced wall thickness of the tee cap increased the proportion of functioning rounds.

2. A reduction in the clearance between the crystal and the tee cap appears helpful when a heavy-wall cap is used, but is not, of itself, sufficient to solve the problem of malfunctions.

Table IV
Summary of Functioning Tests
Lot PA-E 9588

Modification	Fired	Functioned	Target
Heavy-wall cap, .030 in. clearance	10	1	60° homogeneous armor
No tee cap	10	8	2-in. pine screen
Heavy-wall cap, comp. spring, felt insulator	6	3	"
Thin-wall cap, .010 in. clearance	10	9	"
Thin-wall cap, .010 in. clearance, felt insulator	5	4	"
Thin-wall cap, .035 in. clearance	5	4	"
Heavy-wall cap, .010 in. clearance	5	2* (3)	"

*A third round functioned on a steel witness plate placed behind the wooden screen.

T138E57 Projectiles At 2000-yard Range

The Eighteenth and Nineteenth Progress Reports presented data for the performance of the T138E57 projectile when fired at a 1500-yard range. This report presents data for two T138E57 accuracy programs fired at a range of 2044 yards. The two programs were fired at Erie Ordnance Depot from two different T137E1 rifles but the same T152 E3 mount was used in both cases. Complete cartridges as shown in Fig. 7 were used.

Program I

Table V is a copy of the firing record for the first twenty-eight T138E57 inert rounds, fired as received from Picatinny Arsenal, at an 18 ft. by 18 ft. target placed 2044 yards from the gun. The first six rounds were used in "ranging in" on the target. Thirteen of the remaining twenty-two rounds hit the target. The probable errors for the thirteen hits were, V.P.E. = ±.67 mil and H.P.E. =±.63 mil.

The observers reported that three of the nine rounds which missed the target flew well. The remaining six appeared to become somewhat unstable after passing the peak of the trajectory.

Program II

Table VI is a copy of the firing record for the second group of twenty-eight rounds. In this program the target was 24 ft. by 24 ft. The first six rounds were used in "ranging in" on the target. Seventeen of the twenty-two rounds fired after getting "on the target" hit the target with a V.P.E. =±. 76 mil and H.P.E. =±. 83 mil. The measured yaw at the target for all hits was between 1^{o} and 14^{o}. The observers reported that one of the five misses appeared to have good flight but passed about 1 mil right of the target. The other four misses appeared to precess and struck short and left of the target.

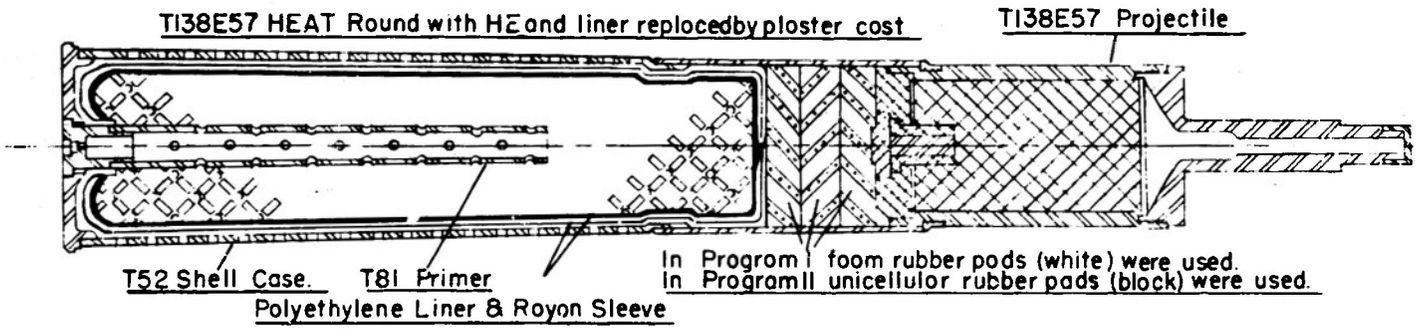

Fig. 7. Complete T138 E57 HEAT Cartridge.

Future Program

Tests to evaluate the various possible causes of malfunctions of the T222 E3 fuze assemblies will continue.

Table V
Accuracy Range Data
T138E57 Projectile At 2044-yard Range
T137E1 Rifle, 18-ft. by 18-ft. Target, Fired 6-5-52

Date: June 5, 1952 Program: T-138 AA
2044 yd. Accuracy Program

PROJECTILE
Model T-138
Type E57
Weight (Nominal) 17.5 lbs.
C.G. Location 5.31 in. from base
Bourrelet Dia. (Nom.) 4.138 +.002 -.000 in.
Special Features DRB 360 Rotating Band

MAGAZINE TEMPERATURE
Minimum 70°
Maximum 71°
Present 70°
LOADING ROOM TEMP. 72°
AMMO. STORAGE TEMP. 75°
AMBIENT TEMPERATURES
10 A.M. 71° 11:30 A.M. 76°
10:45 A.M. 73° 2 P.M. 77°
11 A.M. 75° 3 P.M. 75°

TEST GUN
Model T-137E1
Type 105mm Recoilless
Length of Tube 95 in.
Twist of Rifling 1-20 o
Sighting Equipment M64 Elbow Telescope
Bore Dia. (Lands) 4.134 +.001 -.000 in.

Chamber 21B133C
Breech 22B2698-B
Tube 21B128C
Mount T152E3
Sight Mount T183 #12
MC2 #18009

MISCELLANEOUS DATA
Range 2044 yds.
Propellant PA 3C239
Type M10 MP web: .0336 in. Charge Wt. 8 lbs. 7 ozs.
Primer M57 Warm-Up Rounds
T81 Accuracy Rounds
Proof Director PLACER & CANNERS
Observers Dr. Miller, C.M. Cox, M. Toohig

SCREEN DISTANCES
93' 3" — 69' 5"

73.5 in. = 1 mil at 2044 yds. Zero zero is top left of target Corrected to 68.6 mils elevation, 0 mils azimuth.

Round No.	Proj. No.	Proj. Weight (lb)	Powder Charge (lb - oz)	Wind Vel. & Dir. (mph, deg)	Wind Components (Normal, Parallel)		Muzzle Velocity Instr.	Muzzle Velocity Actual	Elev. (mils)	Azimuth (mils)	Position of Hit (inches) Vert.	Position of Hit (inches) Horiz.	Corrected Position of Hit – mils Vert.	Corrected Position of Hit – mils Horiz.	Bourrelet Diameter Front	Bourrelet Diameter Rear	Clearance Front	Clearance Rear	Observations
2297 - a	Slug	17.34	1 - 14	—	—	—	—	—	—	—									Warm-Up Round
2298 - b	slug	17.34	7 - 14	—	—	—	1615	1652	—	—									Warm-Up Round
2299 - 1			7 - 14	5 - 205	2.0	4.5	1650	1673	62.9	0									Good flight characteristics.
2300 - 2			7 - 14	6 - 230	4.5	3.9	1660	1683	61.5	0									Good flight characteristics.
2301 - 3			7 - 14	5 - 245	6.4	4.1	1665	1678	66.2	0									
2302 - 4			7 - 14	7 - 205	3.0	6.4	1660	1683	66.2	0									Round hit velocity screen.
2303 - 5		Yaw (in.)	7 - 14	4 - 195	1.2	3.9	1665	1678	66.2	0									Good flight characteristics.
2304 - 6			7 - 14	7 - 210	3.6	6.1	1660	1683	71.0	0									Not observed in flight.
2305 - 7	—		7 - 14	5 - 210	2.5	4.3	1665	1688	68.6	0	-90½	+100	-1.29	+1.36					Good flight characteristics
2306 - 8			7 - 14	7 - 210	3.6	6.1	1660	1683	68.6	0									
2307 - 9		6¼	7 - 14	7 - 215	4.2	5.8	1655	1678	68.6	0	-70½	+159	-.96	+2.16					Good flight characteristics
2308 - 10	--	—	7 - 14	7 - 230	5.5	3.9	1666	1688	68.6	0	+32	+155	+.44	+2.11			"	"	"
2309 - 11	--	—	7 - 14	5 - 235	4.2	2.9	1660	1683	67.4	0	-251	+204	-2.22	+2.78			"	"	"
2310 - 12		5	7 - 14	7 - 225	5.0	5.0	1665	1688	68.1	0							"	"	"
2311 - 13	1469		7 - 14	8 - 160	-2.4	7.5	1655	1678	68.6	0	-7	+42	-.10	+.67			"	"	"
2312 - 14	1461		7 - 14	5 - 170	-.8	4.9	1666	1688	67.6	+1.5									
2313 - 15	1473		7 - 14	10 - 210	5.0	8.7	1660	1683	68.6	+1.5									
2314 - 16	1478		7 - 14	4 - 200	1.2	3.8	1665	1678	68.6	0									
2315 - 17	1457	7	7 - 14	10 - 210	5.2	8.7	1650	1673	68.4	0	-62	+111	-.64	+1.51					Good flight characteristics.
2316 - 18	1488		7 - 14	7 - 285	-6.8	-1.8	1645	1668	68.4	0									
2317 - 19	1493		7 - 14	8 - 200	3.0	7.5	1665	1678	68.4	0									
2318 - 20	1466	6½	7 - 14	5 - 195	1.4	4.9	1655	1678	68.4	0	-130	+43	-1.57	+.58					Good flight characteristics.
2319-a	1460	5	7 - 14	8 - 180	0.0	8.0	1650	1673	68.4	0	-177	+11	-2.21	+.15			"	"	"
2320-22	1395	5¼	7 - 14	6 - 195	1.6	5.8	1665	1678	68.4	+1.0	-180½	+136½	-2.26	+.86			"	"	"

Center of Impact _____
Probable Error – Vertical _____
Probable Error – Horizontal _____

Continued on Next Page

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Table V (Cont.)
Accuracy Range Data
T138E57 Projectile At 2044-yard Range

Date June 5, 1952

Program T138E8
2044 Yd. Accuracy Program

PROJECTILE
Model T138
Type E57
Weight (Nominal) 17.5 lbs.
C.G. Location 5.31 in. from base.
Bourrelet Dia. (Nom.) 4.132 +.002 -.002 in.
Special Features DPB 960 Rotating Band

Magazine Temperature
Minimum 70°
Maximum 71°
Present 70°
Loading Room Temp. 72°
Rand. Storage Temp. 76°
Ambient Temperatures
10:00 A.M. 71° 11:30 A.M. 76°
10:45 A.M. 73° 2:00 P.M. 77°
11:00 A.M. 75° 3:00 P.M. 75°

TEST GUN
Model T139E1
Type 105mm Recoilless Rifle
Length of Tube 95 in
Twist of Rifling 1-20
Sighting Equipment M82 Elbow Telescope
Bore Dia. (Lande) 4.134 +.001 in.

Chamber 218133C
Breech 228269B-8
Tube 218128C
Mount T152E3
Sight Mount T183 w/12 M82 w/18009

MISCELLANEOUS DATA
Range 2044 yds
Propellant PA 30239
Type M12MP web .0135 in. Charge Wt. 7 lbs. 14 ozs.
Primer M87 Warm Up Rounds, T81 Accuracy Rounds
Proof Director Placer & Conners
Observers Da Miller, C.M. Coe, M. Tookig.

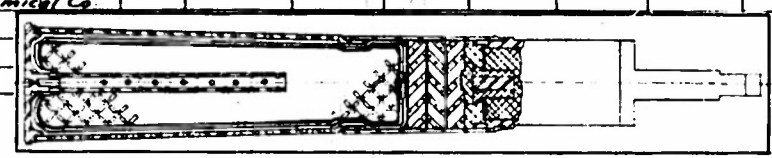
Screen Distances
Rifle 93'3" + 69'5"

79.5 in = 1 mil at 2044 yds. Zero, zero is top left of target. Corrected to 68.6 mils elevation, 0 mils azimuth.

Round No.	Proj. No.	Proj. Weight lb	Powder Charge (lb oz)	Wind Vel. & Dir. (mph, deg)	Wind Components		Muzzle Velocity		Elev. (mils)	Azimuth (mils)	Position of Hit (inches)		Corrected Position of Hit - mils		Bourrelet Diameter		Clearance		Observations
							Instr.	Actual			Vert.	Horiz.	Vert.	Horiz.	Front	Rear	Front	Rear	
2321-23	1462	5½	7-14	6-195	1.8	5.8	1660	1683	68.1	+1.0	-208	+131	-2.95	+.78			Good	flight	characteristics
2322-24	1415		7-14	3-160	-1.0	2.8	1665	1688	68.4	+1.0							"	"	"
2323-25	1435	6¼	7-14	7-210	1.6	6.2	1650	1673	68.6	+1.0	-170	+78	-2.91	+.06			"	"	"
2324-26	1484	—	7-14	5-200	1.8	4.7	1655	1678	68.1	+1.0	-236	+66	-2.71	-.10			"	"	"
2325-27	1468	6"	7-14	9-180	0.0	9.0	1665	1688	69.1	+1.0	-9	+82	-.62	+.11			"	"	"
2326-28	1482	—	7-14	5-210	2.6	4.5	1665	1688	68.6	+1.0									

Rounds were completely assembled by Picatinny Arsenal
Lot PA-E 9511
Rounds consisted of:
T52 prototype cases with polyethylene and rayon liners
Three sponge rubber disks placed on top of propellant charge between outer liner (polyethylene) and base of projectile.
T138E57 type projectile crimped to case (T263 Inert)
Powder PA 30239 M10, MP used.
Primer T81 used, Lot PA-E 9022
Dummy Fuze T208E7 used
Ammunition Lot No. PA-E 9511
Inert Filler:
81% PCN Hydroelectrical Chemical Co.
10% Iron Oxide
9% Celite Johns Manville

Observation Round No.	Notes
3	After about 1000 yards the projectile flight went into an erratic climbing precession, finally dropped off well to right of target.
8	Smooth regular precessional motion after passing trajectory peak
14	Started to precess after passing trajectory peak, completed several precessional revolutions, then broke down and went left of target.
15	No observed precession but flight did not appear to be as smooth as normal good flight.
16	Same as #14 except that it broke down and went right of target.
18	Small precession noticeable over latter part of range.
19	Medium precession observed over last quarter of the range.



Center of Impact V = -1.48 ; H = +1.02
Probable Error - Vertical .69 mil
Probable Error - Horizontal .63 mil

Signed - W. Harvey

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Table VI
Accuracy Range Data
T138E57 Projectile At 2044-yard Range
T137E1 Rifle, 24-ft. by 24-ft. Target, Fired 6-20-52

Date 6-20-52 Program T138A8
2044 yd. Program.

PROJECTILE
Model T138
Type E57A
Weight (Nominal) 17.5 lbs.
C.G. Location 5.91 in. from base.
Bourrelet Dia. (1) 4.132 +.002 -.000 in.
Special Features. Ammunition: T52 Shell Case.
T52 polyethylene & rayon liners.
3 or 4 unicellular pads.
T81 primer.
7 lb-15oz. PA 30239 powder

COMPONENTS:
Chamber - 2283324-A
Ring - 2282448-A
Tube - 2283557
T183 - 10
M62 - 1
T44 - 26

TEST GUN
Model T137E1
Type 105mm Recoilless
Length of Tube 96 in.
Twist of Rifling 1-200
Sighting Equipment T143 sight & Gunners Quadrant.
Bore Dia. (Lands) 4.134 +.001 in.

SCREEN LOCATIONS
93' 3" 45.75' Rds 1&2
93.25' 44.71' Rds 3-28

MISCELLANEOUS DATA
Range 2044 yds.
Propellant PA 30239 Primer T81
Type M1MP web .0885 in. Charge Wt. 7 lb-15oz.
Proof Director E. HUFFMAN
Observers Dr. MILLER, THUEMAN, COX
CLARK, BROWN, O. MILLER

Ave. of a number of recordings taken before & after firing
Reference Points: Vertical - center Horizontal - center
Corrected to: 70.75 mils - center +5 mils - center

Round No.	Case No.	Proj. Weight (lb)	Powder Charge (lb-oz)	Wind Vel. & Dir. mph dir.	Rubber Pads	C.G. Inches from base	Muzzle Velocity Actual	Elev. (mils)	Azimuth (mils)	Position of Hit (inches) Vert.	Horiz.	Corrected Position of Hit - mils Vert.	Horiz.	Bourrelet Diameter Front	Rear	Depth Powder	Pads	Zero Setting (mils)	Yaw Angle	
2373-3004	S22	17.41	7-15	—	3 (Sponge)		1641	68.6 app	0			—	—	—		4½	1	—	—	
2374-3005	S21	17.40	"	—	"		1661	"	0			—	—	—		4½	1½	—	—	
2375-3007	S23	17.46	"	7 - 60	UNICELLULAR 3	5.35	1731	70.76	+2	missed		missed		4.129	4.129	5	⅞	3.7	—	
2376-2090	—	17.43	"	8 - 66	"	5.34	1731	"	+4	missed		missed		4.130	4.129	5	1⅛	3.8	—	
2377-3016	S25	17.46	"	9 - 68	"	5.34	1724	"	+5	+62½	-49	+.87	-.68	4.130	4.129	5	1⅛	3.8	4.5	
2378-3020	S17	17.42	"	9 - 60	"	5.33	1715	"	+5	missed		missed		4.129	4.129	5	1⅝	—	—	
2379-3019	S28	17.44	"	7 - 46	"	6.34	1725	"	+6	missed		missed		4.130	4.130	5⅛	1	4.0	—	
2380-3018	S11	17.49	"	7 - 47	"	5.35	1720	"	+9	missed		missed		4.129	4.129	5	1		6.5	
2381-3017	D209 8	17.42	"	8 - 38	"	5.34	1722	"	+6	-16	+80	-.22	+1.09	4.130	4.129	5¼	1⅜		6.5	
2382-2093	D209 1	17.44	"	9 - 46	"	5.32	1723	"	+5	missed		missed		4.129	4.129	5½	1⅛		—	
2383-2091	D209 3	17.41	"	8 - 44	"	6.33	1719	"	+6	-138	+36	-1.88	+.49	4.130	4.129	5	1¼		—	
2384-2092	S14	17.45	"	8 - 49	"	6.38	1715	"	+6	-137	+8½	-1.86	+.12	4.128	4.128	5½	1⅜		—	
2385-3015	S29	17.45	"	8 - 53	"	5.34	1717	"	+6	-42	-31	-.57	-.42	4.130	4.129	5⅜	1⅜		12	
2386-3000	S19	17.48	"	11 - 49	"	6.34	1726	"	+5	+77	-81	+1.05	-1.10	4.130	4.129	5⅜	1⅜		10	
2387-2095	S18	17.42	"	11 - 45	"	5.32	1716	"	+6	+43½	-30	+.59	-1.41	4.129	4.129	5⅝	1½		6.5	
2388-3009	S15	17.52	"	10 - 31	"	6.34	1715	"	+6	-118	-77	-1.60	-2.05	4.130	4.130	6⅛	1⅝		1	
2389-2096	S25	17.41	"	9 - 50	"	6.35	1716	"	+6½	+36	+69	+.49	-.56	4.130	4.129	5⅝	1½		Very Large	
2390-2094	S21	17.44	"	11 - 30	"	6.34	1713	"	+6	-88	-16	-1.20	-1.20	4.129	4.130	5½	1⅜		6.5	
2391-3001	S23	17.46	"	11 - 36	"	5.34	1713	"	+6	-67	-127	-.91	-2.73	4.130	4.130	5½	1⅜		1	
2392-3002	D209 5	17.47	"	9 - 47	4	6.39	1707	"	+6½	-142	-84	-1.93	-2.64	4.130	4.129	6	⅞		—	
2393-2098	S17	17.46	"	8 - 36	4	5.34	1702	71.26	+6½	-72	+84	-1.48	-.36	4.129	4.129	6	⅞		6.5	
2394-3011	D209 8	17.41	"	8 - 39	3	5.34	1709	"	+6½	missed		missed		4.130	4.129	5½	1⅛		—	
-2088	S22	17.39	"	8 - 51	3	6.33	1716	"	+6	+51	+38½	+.19	+.52	4.130	4.130	5½	1⅜		14	
2396-2099	D209 4	17.46	"	10 - 47	3	6.36	1714	"	+6	+27½	-87	-.13	-1.18	4.130	4.129	5⅝	1		6.5	

Center of Impact _____
Probable Error - Vertical _____
Probable Error - Horizontal _____

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Table VI (Cont.)
Accuracy Range Data
T138E57 Projectile At 2044-yard Range

Date 6-20-52 Program T138B8 2044-yd Program

PROJECTILE
Model T138
Type E67A
Weight (Nominal) 17.5 lbs.
C.G. Location 5.91 in. from base
Bourrelet Dia. (Nom.) 4.132 +.002 -.002 in.
Special Features Ammunition:

COMPONENTS:
Chamber - 2283324-A
Ring - 2282498-A
Tube - 2283557
T183 - 10
M62 - 1
T46 - 26

T52 Shell Cases
T62 Polyethylene & Rayon Liners
3 or 4 unicelluler pads
T81 Primer
7 lb-15 oz. PA 30239 powder

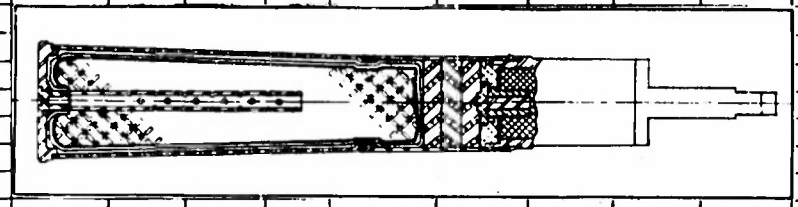
TEST GUN
Model T197E1
Type 105 mm Recoilless Rifle.
Length of Tube 96 in.
Twist of Rifling 1-20D
Sighting Equipment T183 Sight & Gunners Quadrant
Bore Dia. (Lands) 4.134 +.001 in.

SCREEN DISTANCES
63.26' 64.71
Rds 3-28

MISCELLANEOUS DATA
Range 2044 yds
Propellant PA 30239 Primer T81
Type M1 MP web .0356 in. Charge Wt. 7 lb-15 oz.
Proof Director E HUFFMAN
Observers DR. MILLER, THURMAN, COX, CLARK, BROWN, O. MILLER

Round No.	Case No.	Proj. Weight (lb)	Powder Charge (lb-oz)	Wind Vel. & Dir. m.p.h. Dir.°	Rubber Pads	C.G in. from base	Muzzle Velocity Actual	Elev. (mils)	Azimuth (mils)	Position of Hit (inches) Vert.	Position of Hit (inches) Horiz.	Corrected Position of Hit – mils Vert.	Corrected Position of Hit – mils Horiz.	Bourrelet Diameter Front	Bourrelet Diameter Rear	Depth Powder	Depth Pads	Zero Setting (mils)	Yaw Angle (°)
		Ave. of a number of readings taken before & after firing						Reference Points: Vertical – center Horizontal – center				Corrected to: 70.75 mils – center +5 mils – center							
2397-3018	–	17.44	7-15	8 - 52	unicellular 3	5.32	1715	71.25	+5	missed		missed		4.130	4.130	5¼	1	4.0	–
2398-3006	D209 3	17.45	"	9 -45	4	5.34	1709	"	+6	missed		missed		4.130	4.129	5⅜	⅞	"	–
2399-2074	S18	17.43	"	11 -53	3	5.32	1709	"	+6	-1.61	-1.68	-2.65	-2.28	4.130	4.129	5	7/8	"	–
2400-2081	S29	17.46	"	9 -49	4	5.33	1712	"	+6	missed		missed		4.129	4.129	6	1½	"	–
2401-2085	S14	17.40	"	11 -45	3	5.34	1714	"	+7	+.89	-.69	+.71	-2.94	4.130	4.128	5¼	1⅜	"	8
2402-3012	S25	17.46	"	16 -59	4	5.34	1705	"	+8	+.61	+.70½	+.33	-2.04	4.129	4.130	5⅛	¾	"	12

1. All winds are corrected to degrees from line of fire.
2. All rounds consisted of T138E57A projectiles and T52 small-holed cases and were loaded as a unit.
3. Max. temp. = 71°F, Min. temp. = 69°F, Present temp. = 71°F, Powder room = 80°F, Ambient = 68°F.
4. Optical axis and major caliber axis were lined in at 1030 yds.
5. First six rounds used to line in on target, all other rounds fired for accuracy.



Center of Impact V = -.63; H = 1.10 mils
Probable Error – Vertical .76 mil
Probable Error – Horizontal .83 mil

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T171 PROJECTILE

There were no firings conducted with the T171 projectile during the month of June, 1952.

T119 PROJECTILE

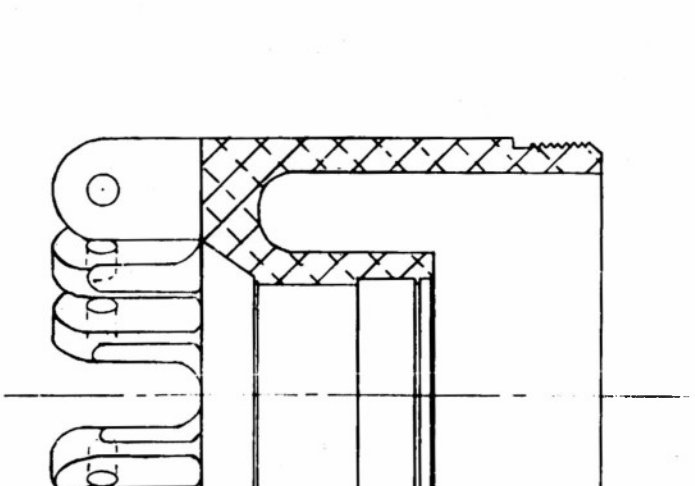
In planning for a pilot lot of 500 T119 projectiles, certain modifications were made to ease manufacturing difficulties. As described in the Twenty-First Progress Report attempts to obtain a cast housing of sufficient strength were unsuccessful. A modified housing, shown in Fig. 8, which could be easily machined from 24S-T4 aluminum bar, was then tested. The first housing tested failed in the gun. It was evident from an examination of the recovered fragments that the housing had collapsed at the threaded end due to the high pressure of the propellent gases. An estimate was made of the stress at the point of failure, and a steel sleeve was designed to strengthen this region (see Fig. 9). The sleeve was pressed into the threaded-end of the housing and four samples of the strengthened housing were fired successfully. The steel sleeve is therefore incorporated in this projectile design.

Table VII contains the data for the firing tests.

Future Program

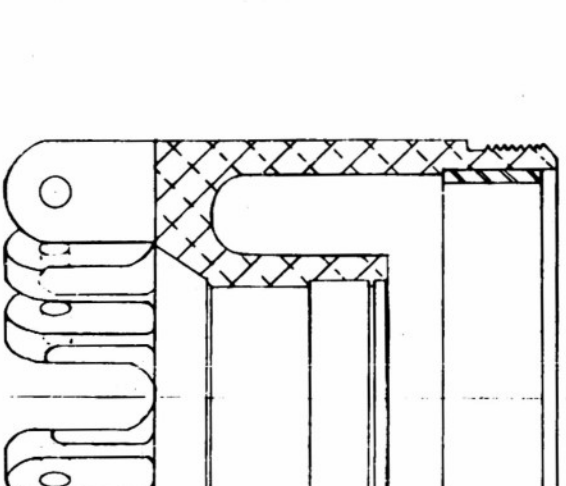
1. Fire a combined accuracy and penetration program using an M27 rifle.

2. Continue the manufacture of a pilot lot of 500 T119 production-type projectiles. The first sample of the forged aluminum fin, planned for use in these rounds has been received and appears to be satisfactory.



HOUSING DRC412-2

Fig. 8. Modified Housing for T119 Projectile.



HOUSING & SLEEVE ASS'Y

Fig. 9. Housing With Steel Sleeve.

Table VII

Range Data, T119 Projectile

To Test Aluminum Housing DRC 412

Date June 11-29-52 Program T119E2

PROJECTILE

Model T119

Type Blunt Nose for Recovery

Weight (Nominal) 17.7 lb.

C.G. Location ——

Bourrelet Dia. (Nom.) 4.164 +.002 in.

Special Features Mesa Housing DRC 412

COMPONENT PARTS

Blunt Nose
Body - DRC 341-4
Plug - DRB 419-5
Dummy Base Element DRA 269
Plug - DRA 288-9
Housing - DRC 412-2
Housing Sleeve -
Piston - DRB 198-5(a)
Stop - DRA 173-4
Fin - DRB 49
Inert Load - Plaster

TEST GUN

Model Modified T19 Recoilless

Type 30° breech, 500 cu in chamber liner.

Length of Tube 106 in.

Twist of Rifling Smooth bore.

Sighting Equipment Adapted M17 Elbow Telescope.

Bore Dia. (Lands) 4.134 +.002 in.

Modified T6 Case
M57 Primer
Polyethylene Liner

MISCELLANEOUS DATA

Range Recovery Box - four yaw cards

Propellant
Type HIGMP web 0.095 in Charge Wt. Variable
Lot No. PA90239

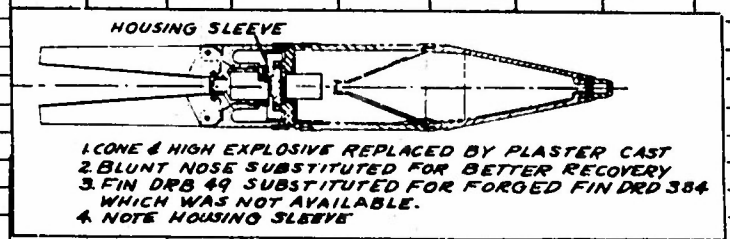
Proof Director E. HUFFMAN

Observers ENGEBRETSON, HERLEY
LUCAS, TOONIG.

Round No.	Date Fired	Proj. Weight (lbs)	Powder Charge lbs oz	Recoil inches-rear	Chamber Pressure	Housing Sleeve Length (in.)	Housing Sleeve Thickness (in.)	Observations
2327-Shg	6-11-52	—	7-14	1	8810	—	—	Projectile No. 137 failed in the gun. Aluminum gall marks were found in the gun tube.
2328-137	"	17.49	7-14	5 1/4	8930	no sleeve		The first yaw card, at 30 ft. from the muzzle showed projectile separation. Re-
2329-169	6-16-52	17.71	8-0	—	10100	.75	.094	covered parts showed collapse of housing at threaded end. Projectile No. 169
2403-168	6-23-52	17.92	8-0	—	10180	"	.063	escaped from recovery box and was lost, but yaw cards indicated satisfactory
2404-171	"	17.91	8-0	—	9485	"	.094	performance.
2405-170	"	17.92	8-0	—	9460	"	.063	All other projectiles recovered. No failures occurred when housing sleeve was used.

(a) Piston orifice diameter .245 in.

(b) Housing sleeves for these tests were machined from SAE 4340 steel bar which was bored, heat treated and then finished to the final dimensions. The finished sleeves had Rockwell hardness of 37-38 on the C scale.



1. CONE & HIGH EXPLOSIVE REPLACED BY PLASTER CAST
2. BLUNT NOSE SUBSTITUTED FOR BETTER RECOVERY
3. FIN DRB 49 SUBSTITUTED FOR FORGED FIN DRD 384 WHICH WAS NOT AVAILABLE.
4. NOTE HOUSING SLEEVE

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PENETRATION STUDIES

Tests With T171 Type Projectile Body

Table X of the Sixteenth Progress Report showed data obtained in tests at the Ballistics Research Laboratories at Aberdeen Proving Ground with the T171 type projectile (DRC193 body and a DRB83 nose ring as shown in Fig. 15 of the Sixteenth Progress Report). The poor performance of the round was attributed to the nose ring design. Accordingly ten rounds were prepared using DRC 193 bodies and DRB91 nose rings as shown in Fig. 10. As before, DRB2, 45°, .100-in. wall copper cones were used. These rounds were loaded with Comp B at Ravenna Arsenal and fired at Erie Ordnance Depot. The test data are presented in Table VIII.

The change in the ring resulted in a doubling of the penetration. The slight effect of increased standoff is of considerable interest.

Penetration type rounds with DRB2 cones normally have a penetration of 18.0 in. at a standoff of 7.5 in. and 22.0 in. at a standoff of 18.0 in. It would therefore appear that less standoff is required for optimum performance when the charge is tapered. Further tests are being considered.

Now that the potential penetration of the T171 type round has been established further accuracy tests would be appropriate.

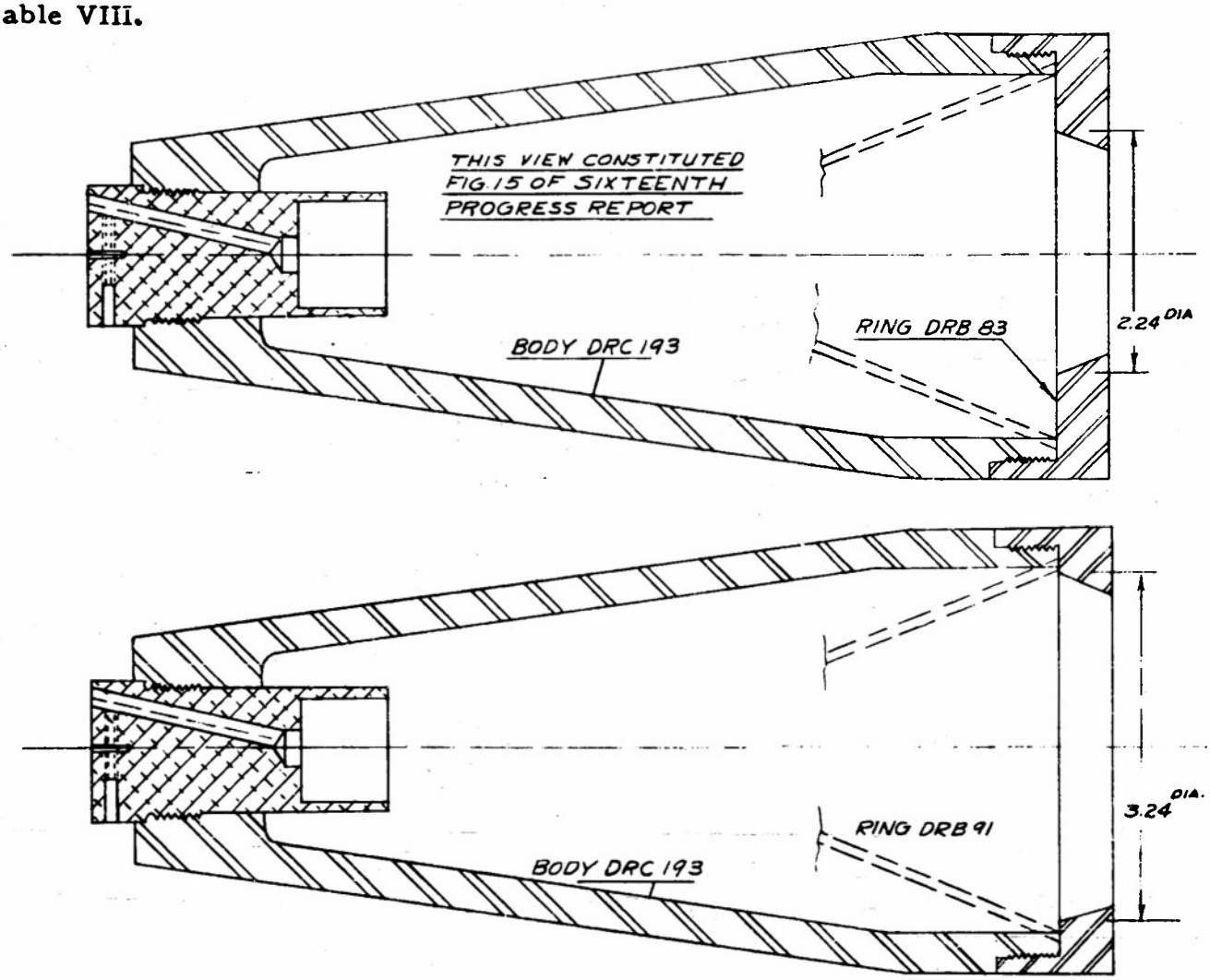


Fig. 10. T171 Type Penetration Assemblies.

Table VIII

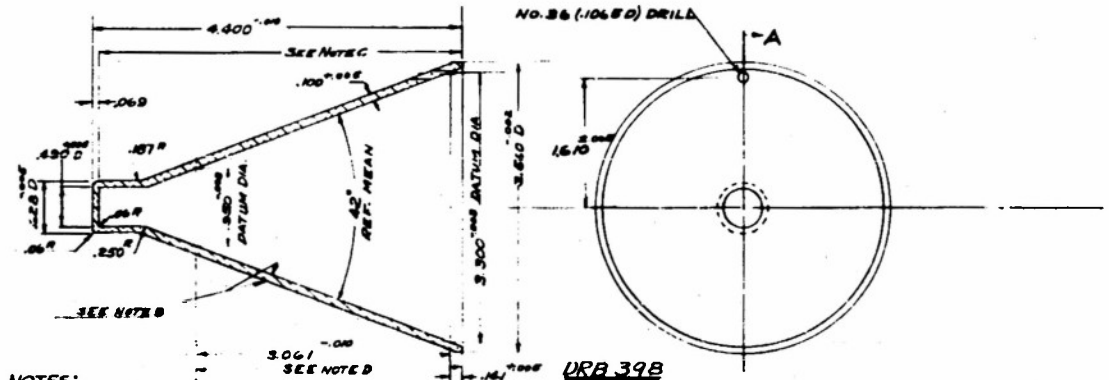
Penetration Data for T171 Type Projectile

Round No.	Lbs. Comp B	Rev/Sec	Standoff (inches)	Penetration inches M.S.	Max. Spread (in.)	Std. Deviation (in.)
P551	1.86	0	7.5	19.38		
P552	1.86	"	"	19.18		
P553	1.86	"	"	21.69		
P554	1.88	"	"	21.25		
P560	1.88	"	"	19.50		
				Avg. 20.20	2.51	±1.11
P555	1.86	0	18.0	18.56		
P556	1.86	"	"	20.00		
P557	1.88	"	"	22.69		
P558	1.88	"	"	21.56		
P559	1.88	"	"	20.94		
				Avg. 20.75	4.13	±1.58

Notes:
1. DRC193 bodies, DRB91 Nose Rings, DRA53 base plug.
2. Loaded at Ravenna Arsenal, BAT Lot No. 9, Comp B Holston Lot 3-126
3. Tested at Erie Ordnance Depot.

DRB 398 Copper Cones

The copper cones being used in the T138E57 and T119 HEAT projectiles are drawn from copper sheet and finished in accordance with DRB398 as shown in Fig. 11. The penetrating power of these cones in both DRC376 test bodies and T138 E57 projectiles, with different boostering systems, and at different spin rates has been determined. The inspection data for all of the cones included in these experiments are shown in Table IX.



NOTES:
A. FINISH
B. ALL INDICATED SURFACES MUST BE CONCENTRIC WITHIN .003 T.I.R. WITH RESPECT TO 3.560 REGISTER DIA.
C. ALL INDICATED SURFACES MUST BE FLAT & PARALLEL WITHIN .005 T.I.R. & PERPENDICULAR TO ℄ OF PART
D. IN THIS REGION VARIATION IN STRAIGHTNESS OR THICKNESS OF WALL SHALL NOT EXCEED .006 IN ANY AXIAL PLANE. VARIATION OF WALL THICKNESS IN ANY TRANSVERSE PLANE SHALL NOT EXCEED .005
E. PREFERRED MATERIAL: OXYGEN FREE, NO RESIDUAL DEOXIDANTS, COPPER. ALTERNATIVE MATERIAL: ELECTROLYTIC TOUGH PITCH COPPER. COPPER, DEEP DRAWING; SEE NOTE E SPEC QQ-C-576

Fig. 11. DRB 398, 42-degree Copper Cone.

Table IX

Inspection Data for DRB 398 Cones

See Tables X and XI for Penetration Results

Cone No.	Max. Trans. Variation	Max. Long. Variation	Min. Wall Thickness	Max. Wall Thickness
Q341	.002	.007	.098	.105
Q342	.003	.006	.097	.103
Q343	.003	.004	.098	.102
Q344	.005	.008	.095	.103
Q345	.002	.004	.097	.102
Q346	.003	.005	.097	.103
Q347	.002	.004	.097	.102
Q349	.002	.003	.099	.102
Q350	.004	.003	.099	.103
Q351	.002	.002	.099	.101
Q352	.003	.003	.098	.102
Q353	.002	.002	.098	.100
Q354	.004	.005	.097	.102
Q355	.003	.002	.099	.102
Q383	.003	.005	.097	.102
Q384	.003	.006	.098	.104
Q385	.004	.007	.096	.104
Q386	.003	.005	.099	.105
Q387	.004	.006	.098	.104
Q388	.004	.006	.096	.102
Q389	.003	.007	.095	.103
Q390	.004	.006	.097	.104
Q397	.003	.006	.096	.103
Q398	.003	.006	.098	.105
Q399	.003	.005	.099	.105
Q400	.003	.006	.097	.104
Q401	.003	.006	.097	.103
Q402	.003	.005	.098	.103
Q403	.003	.005	.098	.104
Q404	.003	.005	.097	.103
Q405	.003	.006	.098	.104
Q422	.003	.006	.096	.102
Q428	.003	.005	.098	.103
Q429	.004	.007	.096	.103
Q430	.002	.006	.096	.102
Q431	.003	.005	.098	.105
Q432	.003	.006	.098	.104
Q433	.003	.006	.096	.102
Q483	.004	.006	.097	.104
FS518	.002	.002	.102	.104
FS521	.001	.004	.103	.107
FS523	.001	.001	.103	.104
FS524	.000	.001	.103	.104
FS528	.000	.002	.105	.107

Effect of the Booster System

In actual projectiles initiation of the Composition B is accomplished by means of the T208E7 base element. In static penetration tests it is more convenient to employ a dummy base element system. Figure 12 illustrates the two systems. Nine DRB398 cones, cased in DRC376 test assemblies, were loaded at Ravenna Arsenal and tested for penetration into mild steel at Erie Ordnance Depot. Five rounds utilized the penetration test base element system and four rounds contained T208E7 base elements which had previously been armed in a centrifuge. All rounds were tested at 0 rev/sec and at a standoff of 7.50 inches. The penetration data are presented in Table X, Part A. The average penetration measured for the two booster systems agrees within the known experimental error. It is concluded (1) that the T208E7 base element provides adequate boostering for either the T138E57 or the T119 HEAT round, and (2) that the penetration booster system may be used interchangeably with the T208E7 base element in static penetration tests.

An examination of the radiographs of all rounds has revealed that three of the cones used with the penetration booster system and one of the cones used with the T208E7 system had been distorted in being pressed into the nose rings, as shown in Fig. 13. The average penetration of the four distorted cones is 17.8

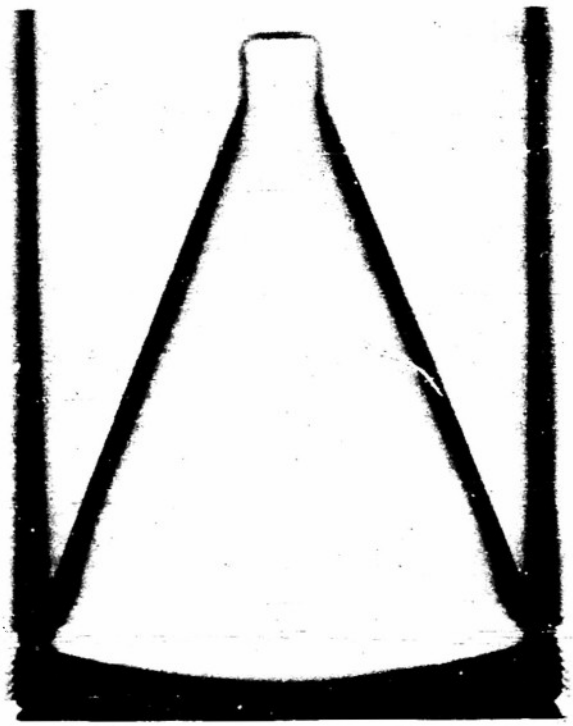


Fig. 13. Radiograph Showing Distorted Cone.

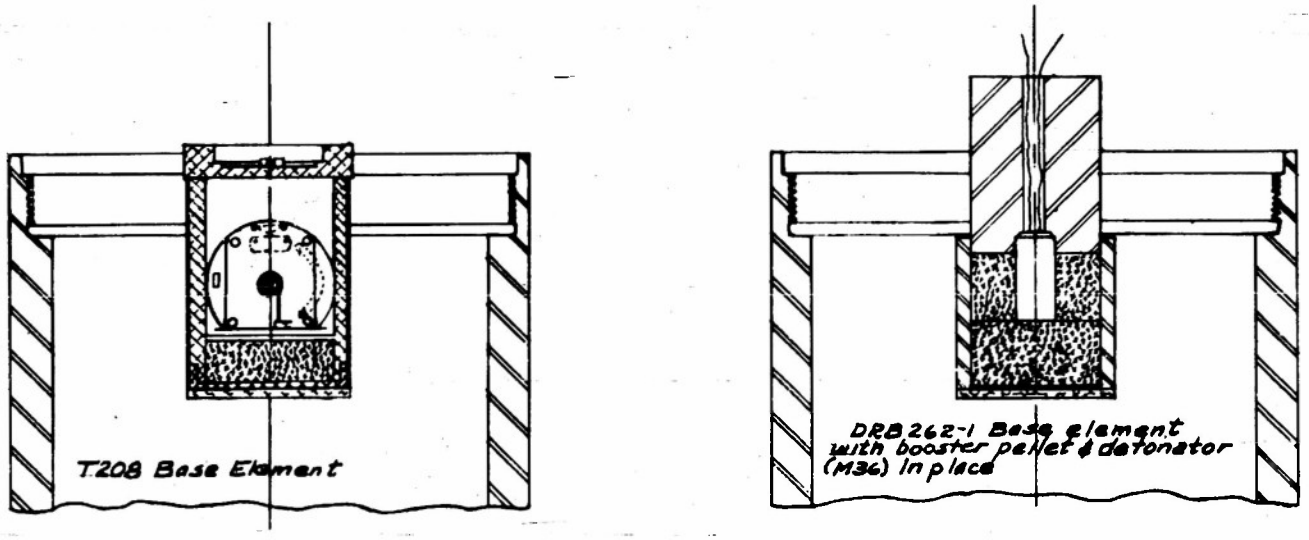


Fig. 12. Two Means of High Explosive Initiation.

inches, while the average for the undistorted cones is 19.8 inches. It is apparent that great care must be exercised in the assembly of cones into tees (or rings) to prevent such distortion.

Machined Versus Drawn Liners

Five cones were carefully machined to drawing DRB398 from hard drawn copper bar. These cones were assembled in DRC376 test assemblies and tested for penetration into mild steel at 0 rev/sec and 7.50 inches standoff. The data are shown in Table X, Part B. The average penetration of 19.5 inches shows that machined and drawn cones penetrate equally well when well made.

Table X

Penetration Test Data

Effect of Booster System On Penetration
and
Penetration Results With Machined DRB 398 Cones

DRC 376 Test Assemblies
Standoff - 7.50 inches
Spin - 0 rev/sec
Loaded at Ravenna Arsenal, BAT Lot No. 8, Holson Lot 3-126

Round No.	Booster System	Lbs. Comp B	Penetration (inches M.S.)	Max. Spread (in.)	Std. Deviation (in.)
Part A Effect of Booster System (Fig. 12), DRB398, Drawn Cones					
Q383	Test	2.46	18.81*		
Q384	Test	2.48	20.31		
Q385	Test	2.48	17.25*		
Q386	Test	2.46	16.69*		
Q387	Test	2.48	20.18		
		Avg.	18.63	3.62	±1.65
Q388	T208E7	2.48	19.62		
Q389	T208E7	2.50	18.56*		
Q390	T208E7	2.50	18.88		
Q397	T208E7	2.48	20.12		
		Avg.	19.29	2.56	±.71
*Distorted Liners					
Average penetration for all distorted liners					17.83 inches
Average penetration for all undistorted liners					19.82 inches
Part B Machined DRB398 Cones					
FS518	Test	2.44	18.62		
FS521	Test	2.48	19.44		
FS523	Test	2.48	19.81		
FS524	Test	2.46	19.62		
FS528	Test	2.46	19.75		
		Avg.	19.45	1.19	±.48
(Compare with average for undistorted cones - 19.82 in.)					

Effect of Rotation

The effect of rotation upon the penetration of drawn copper cones when cased in DRC376 test assemblies and when cased in T138E57 assemblies is shown in Table XI and Fig. 14. All rounds utilized the penetration test booster systems.

Certain of the rounds shown in Table XI contained cones which had been distorted during assembly of the rounds. The penetration data clearly shows the loss in penetration resulting from this cone distortion.

At 25 rev/sec the penetration is independent of the type of assembly but at zero rev/sec the penetration is nearly five inches greater using the DRC376 test assembly than with the T138E57 assembly. These data suggest that the tee does not interfere with penetration at 25 rev/sec, but that it reduces penetration substantially at zero rev/sec. Additional tests are now being conducted to more precisely determine the magnitude of the effect of the tee.

Table XI

Penetration Test Data

Effect of Rotation Upon Penetration of DRB 398 Drawn Cones

Round No.	Lbs. Comp B	Rev/Sec	Penetration (inches M.S.)	Max. Spread (in.)	Std. Deviation (in.)
DRC 376 Test Assembly: Ravenna BAT Lot No. 8 Holston Lot 3-126					
Q384	2.48	0	20.31		
Q387	2.48	0	20.18		
Q388	2.48	0	19.62		
Q390	2.50	0	18.88		
Q397	2.48	0	20.12		
			Avg. 19.82	1.43	±.59
Q398	2.48	25	13.31		
Q399	2.50	25	13.56		
Q400	2.48	25	13.69		
Q401	2.50	25	13.18		
Q402	2.46	25	13.69		
			Avg. 13.49	.51	±.24
Q429	2.46	30	12.00		
Q430	2.48	30	13.88		
Q431	2.48	30	11.94		
			Avg. 12.44	1.94	±1.13
Q403	2.48	45	12.25		
Q404	2.46	45	10.25		
Q405	2.44	45	13.06		
Q422	2.50	45	7.75		
Q428	2.48	45	11.69		
			Avg. 11.00	5.31	±2.09

Continued on next page

Table XI (Cont.)

Round No.	Lbs. Comp B	Rev/Sec	Penetration (inches M.S.)	Max. Spread(in.)	Std. Deviation (in.)
Q432	2.48	60	7.06		
Q433	2.48	60	7.38		
Q483	2.50	60	7.18		
		Avg.	7.21	.32	±.16
T138E57 Assembly: Picatinny Arsenal, PA-E 9695, Holston Lot 3-166					
Q341	2.30	0	(13.31)*		
Q344	2.26	0	15.50		
Q345	2.28	0	16.50		
Q349	2.24	0	14.69		
Q352	2.28	0	13.75		
		Avg.	15.11	2.75	±1.17
Q343	2.27	25	(10.75)*		
Q346	2.29	25	13.44		
Q351	2.29	25	13.80		
Q354	2.30	25	13.94		
Q355	2.31	25	13.81		
		Avg.	13.77	.50	±.23
Q342	2.27	30	(11.75)*		
Q347	2.29	30	13.06		
Q350	2.29	30	12.81		
Q353	2.31	30	(12.06)*		
		Avg.	12.94	.25	--
T138E57 Assembly: Picatinny Arsenal, PA-E 9806, Holston Lot 3-89					
768	2.28	0	15.06		
811	2.30	0	14.75		
821	2.30	0	14.75		
877	2.27	0	16.38		
989	2.31	0	15.56		
		Avg.	15.30	1.63	±.69
254	2.28	25	16.12		
356	2.28	25	12.56		
769	2.28	25	15.62		
773	2.30	25	14.56		
819	2.26	25	15.50		
		Avg.	14.89	3.56	±1.41

Notes: * Cones distorted, not included in average.

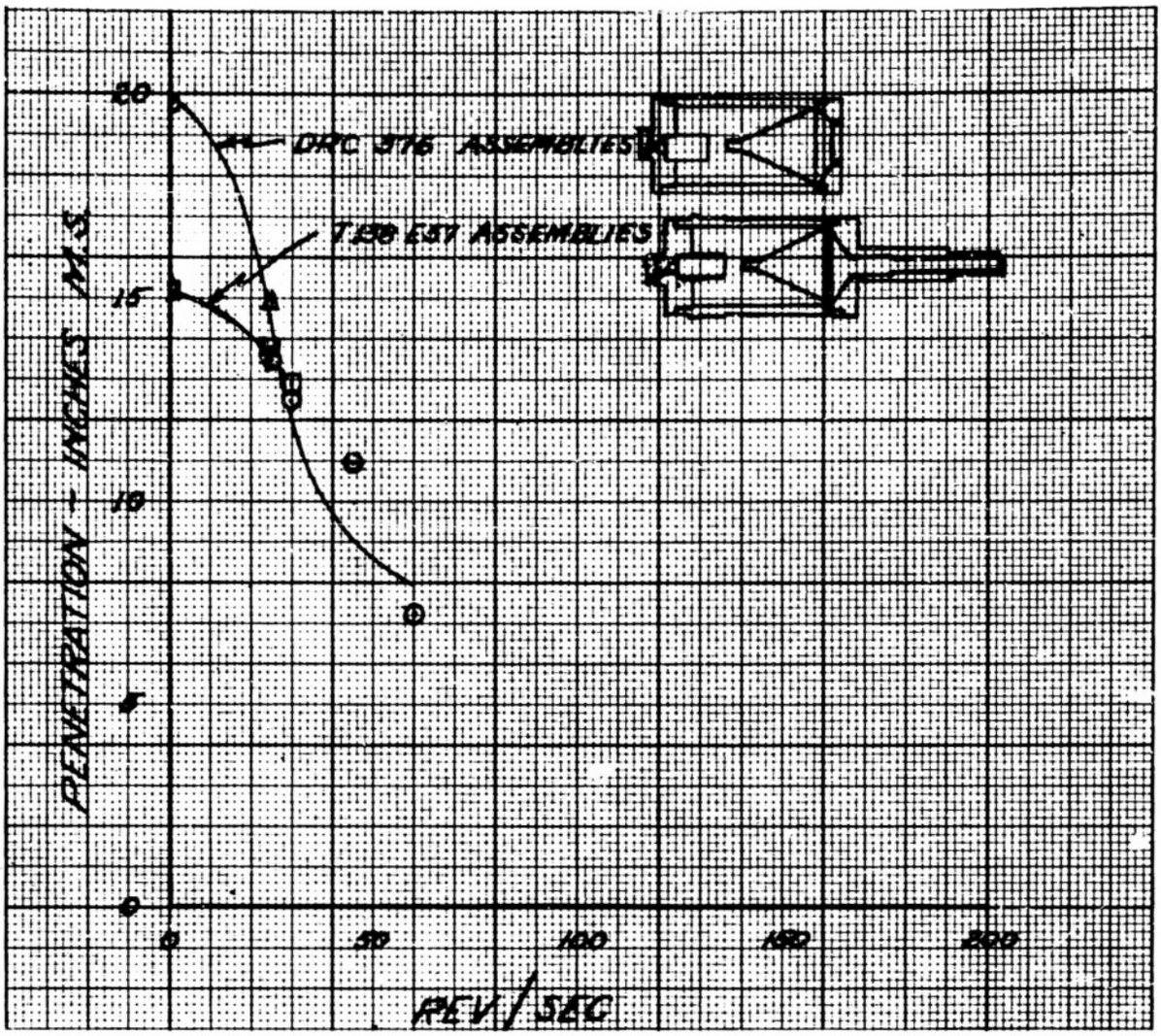


Fig. 14. Rotation Verus Penetration.
DRC 376 Assemblies and T138 E57 Assemblies.

Future Program

1. Conduct penetration versus stand-off tests for 45° and 20° copper cones (.100-inch wall) with the head of H.E. held constant at 3.63 inches.

2. Evaluate the influence of DRC314 tees made of (a) mild steel (b) high ductility malleable iron, and (c) low ductility malleable iron.

3. Compare DRC314 tees and DRC376 nose rings with respect to their effect upon penetration.

4. Compare DRC376 test assemblies employing the penetration test base element assembly and similar rounds with the booster set in the base plug (No dummy base element).

Calculation and Measurement of Impulse Sustained by a T138E57 Projectile In Passing Through a Bursting Screen

The impulse sustained by a projectile, in perforating a wood bursting screen, is equal to the sum of (1) the impulse required to shear out a plug of wood and (2) the impulse required to accelerate the wood punched out of the target. Neglecting the shear impulse, a value for the ratio of the velocity after hitting the screen to the velocity before hitting the screen, can be calculated as follows:

Let A=cross sectional area of proj.-sq. in.
t=thickness of screen - inches
d=density of screen - lb/cu. in.
g=gravitational constant-32 ft/sec/sec.
m=mass of wood punched out
M=mass of projectile
V_1 =striking velocity of projectile-ft/sec
V_2 =exit velocity of projectile-ft/sec.
=velocity attained by wooden plug

Then,

$$m = \frac{Atd}{g} \qquad (1)$$

$$M(V_1 - V_2) = mV_2 \qquad (2)$$

$$MV_1 = V_2(M+m) \qquad (3)$$

$$\frac{M}{M+m} = \frac{V_2}{V_1} \qquad (4)$$

A firing program to test Equation (4) has been completed. One set of velocity screens was set up in front of a bursting screen and a second set was placed behind the bursting screen. The firing data and the comparison of experimental and calculated ratios are shown in Table XII.

The experimental ratio is corrected for the loss of velocity that occurs in air, as determined by rounds 2484, 2485 and 2486 in Table XII.

It appears that the loss in momentum experienced by a projectile passing through

Table XII

Firing Data

Measurement of Impulse Sustained By T138E57 Projectile Passing Through a Bursting Screen

Round No.	Weight of Projectile(lb)	Screen Thickness (in.)	Instrumental Velocity(f/s) V_1	Instrumental Velocity(f/s) V_2	$V_2 - V_1$	$(V_2 - V_1)$ corr'd	V_1 corr'd	V_2 corr'd	$\frac{V_2}{V_1}$ Exp.	$\frac{V_2}{V_1}$ Calc.
2484-1	17.14	0	1652	1626	26					
2485-2	17.12	"	1681	1660	21					
2486-3	16.84	"	1698	1677	21					
Avg.	17.03	"	1677	1654	23	0	--	--	--	--
2488-5	17.43	1.62	1672	1596	76					
2489-6	17.37	"	1675	1617	58					
2490-7	17.10	"	1687	1619	68					
Avg.	17.30	"	1678	1611	67	44	1666	1622	.974	.979
2492-9	16.56	3.25	1714	1623	91					
2493-10	17.20	"	1693	1585	108					
2496-13	17.37	"	1672	1594	78					
Avg.	17.04	"	1693	1601	92	69	1681	1612	.959	.958

Notes:
1. Screen spacing Muzzle — 112'6" — A — 72'3¾" — B — 214½" — C — 58'3½" — D
2. Target screen placed midway between screens B and C
3. Density of dry screen taken as 30 lb/cu. ft.
4. T137E1 Rifle and T152E2 Mount.

a wood bursting screen at 1700 ft/sec is nearly equal to the momentum acquired by the wood that is removed from the target. The small difference between the measured and calculated ratio is a measure of shear impulse. It is apparent that, in the case of a wooden screen, the shear impulse is negligible.

Evaluation of the Effect of RC Washer

In considering the malfunctions encountered in the T138E57 HEAT rounds fired at Aberdeen Proving Ground the question arose as to the effect of this RC washer upon the sensitivity of the fuze system. An experiment to show the effect of this RC washer on fuze sensitivity has been performed, using the drop-tester. A crystal, tee and tee cap assembly was mounted in the tester and dropped from various heights. The tee cap had .030-in. walls and .010 in. clearance between cap and crystal. A heat squib (the equivalent of the T18 detonator from an energy requirement) was connected across the crystal and was used to determine functioning. In the first experiment the heat squib was used alone, in the second an RC washer was placed in parallel with the heat squib, and in the third .100-in. wall caps were used.

Table XIII shows the data for these tests. Some experimental difficultie

Table XIII

Test Data

Evaluation of the Effect of RC Washer

Drop Sequence	Drop Height (in.)	Squib Resistance	RC Resistance	Parallel Res. of Squib and RC	Tee Cap Wall	Clearance	Tee Cap Distortion	Condition of Lucky after Drop	Results
1	36	--			.030	.010		Powdered	OK
2	12	--			.030	.010		"	No Probable open
3	12	4300			.030	.010		Crumbled	OK circuit
4	6	3400			.030	.010		Chipped	OK
5	3	1800			.030	.010		No Damage	NO
6	6	1800			.030	.006		Chipped	No Probable short
7	6	1700			.030	.010		"	OK
8	5	1700			.030	.010		"	OK
10	4	3800			.030	.010		No Damage	OK
11	4	4100			.030	.010		"	OK
Drops 12 & 13 used the same heat squib and different caps.									
12	3	4200			.030	.010		"	NO
13	4	4200			.030	.010		"	OK
Drops 17, 18 & 19 used the same heat squib and different caps.									
17	3	3000			.030	.009	.007	"	NO Open circuit
18	3	4200			.030	.008	.003	"	NO " "
19	3	4500			.030	.010	.003	"	OK
20	3	2400			.030	.010	.008	"	NO
21	4	1900			.030	.010	.010	"	OK
Drops 22, 23, 24, & 25 used the same heat squib and different caps, except 24 & 25 used the same cap.									
22	4	3600			.030	.012	.011		NO Open Circuit
23	4	3300			.030	.012	.010		NO}
24	4	3500			.030	.012	.009	Same cap	NO} Bad Squib
25	4	3600			.030	.003	.003		NO}
9	5		120K	2800	.030	.010		Chipped	OK
14	4		120K	3200	.030	.010		No Damage	OK
26	4	same squib	156K	2600	.030	.010	.008	No Damage	OK
27	4		156K	2200	.030	.010	.009		NO
28	4		156K	2150	.030	.010	.009		OK
29	4		156K	3800	.030	.010	.008		NO
30	5		110K	2400	.030	.010	.012		OK
31	5		110K	1650	.030	.010	.011		OK
32	5		110K	3200	.030	.010	.009		OK
33	5		160K	3500	.030	.010	.013		OK
34	5		160K	1500	.030	.010	.012		OK
15	48	4500			.100	.005-9	.069	Powdered	OK
16	24	4600			.100	.008	.028	"	OK
35	12	2600			.100	.010	.009		NO
36	12	3000			.100	.010	.011		OK
37	12	1300			.100	.010	.011		OK
38	12	2400			.100	.010	.009		OK
39	12	2100			.100	.010	.010		OK
40	12	4100			.100	.010	.011		OK

such as shorts, open circuits and faulty techniques were experienced. However, the results of Part I show that a drop of 3 inches was sometimes sufficient for functioning; a drop of four inches was frequently sufficient, and a drop of six inches was usually sufficient. When an RC washer was placed in parallel with the heat squib very consistent functioning was observed with five-inch drops. With a heavy wall cap (.100 in.) a drop of twelve inches functioned the heat squib in five of six tests. No shorter drops were tried.

These data indicate that:

(1) The RC washer causes no important decrease in the sensitivity of the system.

(2) A tee assembly mounted in the drop tester with a cap having .100-in. wall functions the heat squib on a 12-in. drop.

Performance Test of Fuze, PD, T222E4 (T222E3 Nose Element, FBE 6 [DRD 260] Base Element)

Ten FBE6 base elements (DRD260), loaded with heat squibs, (T18 detonator without lead azide) were assembled in T138 E57 projectiles, and fired through a bursting screen into a recovery box. The tee caps had wall thicknesses of .010 in. and the base elements had all armed satisfactorily when tested in the centrifuge. Five of the units had been modified by putting projections on the base terminals, in an effort to get more positive electrical contact. Nine of the ten rounds were recovered. Six of the nine base elements had armed, but none of the heat squibs had functioned. Examination of the three unarmed base elements showed that the pins were rusty and upon removal of this rust the rounds armed, as expected, when retested in the centrifuge. The base elements had been permitted to stand for some days in freshly filled inert rounds and it seems likely that the moisture from the plaster cast caused the rusting. In five of the six armed base elements recovered, the base terminal had been driven forward by impact. Since this can occur only if the rotor is in the armed position at impact, the best explanation for the failure to set off the heat squibs is that insufficient electrical energy was supplied.

Failure to supply sufficient electrical energy can be caused by a failure in the electrical circuit, an open or short, or by some failure of the nose element. Since the tee caps were thin-walled (.010 in.) it was decided to investigate other possibilities. A base element which had armed but which had failed to fire the heat squib was reassembled in the unarmed position, placed in centrifuge, and accelerated sufficiently to arm. The exact time of arming was determined by means of suitable slip rings connected to the terminals. The armed base element was removed from the centrifuge and an attempt was made to fire it by compressing a crystal assembly connected across the terminals. It was not possible to fire the heat squib but the heat squib itself was fired easily when connected directly to the crystal assembly.

These tests, together with those reported in the Twenty-Second Progress Report, indicate that some of the trouble encountered with poor functioning of the FBE6 base element is caused by failure of the sliding contact. This contact system is very similar to that used in the T208 base element.

A model of a redesigned contact has been made and tested. The base element was run in the centrifuge in the reversed position and it was found that over 2000 g's acceleration were necessary to cause the modified contact to open. Further tests with base elements, embodying this modified contact, are planned.

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